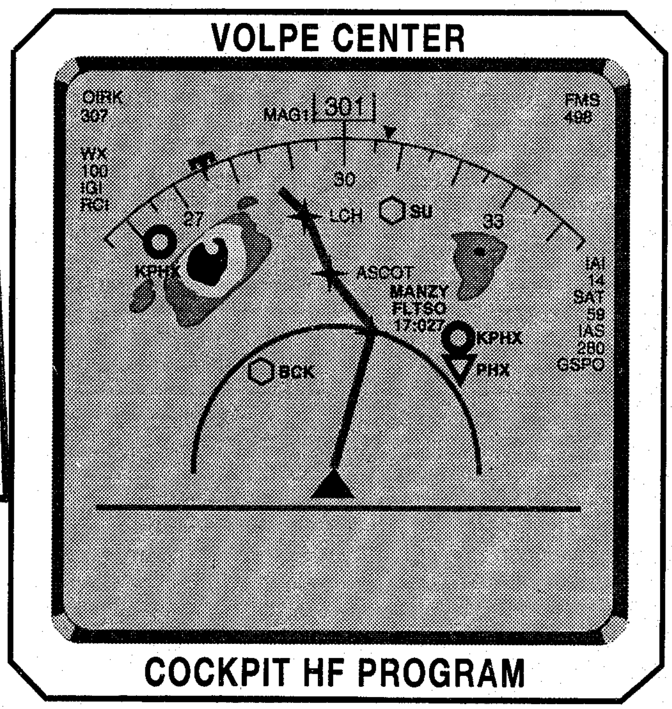
Evaluation of Prototype Air Carrier Instrument Approach Procedure Charts

DOT/FAA/95/44
DOT-VNTSC-FAA-95-24

Office of Aviation Research
Washington, DC 20591



U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Final Report
July 1995

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

NOTICE

# REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE July 1995	3. REPORT TYPE AND DATES COVERED Final Report January 1993 - May 1995

4. TITLE AND SUBTITLE
Evaluation of Prototype Air Carrier Instrument Approach Procedure Charts

5. FUNDING NUMBERS
FA5E2/A5007

6. AUTHOR(S)
R. D. Blomberg, E. W. Bishop, J. W. Hamilton

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Dunlap and Associates, Inc.*
1010 Summer Street
Stamford, CT 06905

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FAA-95-24

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Aviation Administration
Chief Scientific and Technical Advisor for Human Factors
Washington, DC 20591

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
DOT/FAA/95/44

11. SUPPLEMENTARY NOTES
*under contract to: Battelle Memorial Institute**
505 King Avenue
Columbus, OH 43201
**under contract to: U.S. Department of Transportation
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

12a. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the National Technical Information Service, Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
The objective of this study was to evaluate the design features of two prototype Instrument Approach Procedure (IAP) charts. The John A. Volpe National Transportation Systems Center in cooperation with the Air Transport Association's Chart and Data Display Working Group prepared one of the prototypes, and the other was produced by Jeppesen Sanderson. The study was designed to compare each prototype to the current Jeppesen chart, and to compile the results in the form of recommendations for revision of one of the prototypes or for the design of a new IAP chart. Pilots' opinions of the speed and accuracy with which they could acquire and use the information shown and their preferences for the unique features of each were the primary evaluative measures. Scaling techniques were used to obtain the pilots' opinions, preferences and assessments of each chart's suitability for use in approach briefing, normal approach, and go-around. A total of 91 air carrier pilots from four airlines operating under Part 121 of the Federal Aviation Regulations took part in the study.

The results showed that while the pilots were resistant to changes in approach chart design before seeing either of the prototypes, they accepted many of the new features of both prototypes and suggested additional changes after they were introduced to the new ideas. The recommendations for an improved instrument approach chart include features from both prototypes. The recommended chart design is compatible with current chart production and distribution procedures, and it is feasible to introduce it on a phased basis, changing all of the charts at any given airport at one time. It presents the information needed to brief an approach in a "Briefing Strip" at the top of the chart. This strip includes a pictorial of the lighting to be expected on the runway being used. Other innovations include the depiction of the initial steps of the missed approach procedure using pictorials or "icons" in addition to the traditional narrative and selective bolding and increases in type size.

14. SUBJECT TERMS
icons, briefing strip, instrument approach procedure charts, pilot performance, cockpit human factors

15. NUMBER OF PAGES
212

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in.) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32) (5/9)] °F = y°C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (kn^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5	6	7	8	9	10

CENTIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

25.40

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

PREFACE

This report describes a study which evaluated a number of individual design changes that had been proposed to enhance the usability of instrument approach procedure (IAP) charts for air carrier pilots. These changes were depicted in two prototype formats which were compared for usability against the current standard chart format. Currently active pilots flying simulated approaches in Phase II and Phase III simulators provided the data and information on which the comparisons were based. The design changes were assessed for pilot acceptability and perceived utility during approach briefings, while flying approaches, and while performing missed approach procedures.

The pilots who took part in the study initially expressed a reluctance to accept changes in IAP chart design. After having been briefed on the prototype formats and having "flown" one or the other format in the simulators, however, they expressed strong preferences for the prototype charts over the standard. They also evidenced strong preferences for several design features from both prototype charts. These preferred features have been combined with acceptable current features to produce a single composite chart. The design rationale for the composite chart is presented in detail in this report.

This study was conducted as a cooperative effort among the Air Transport Association (ATA) Chart and Data Display Working Group, Continental, Delta, Northwest, and United Airlines, the John A. Volpe National Transportation Systems Center, and Jeppesen Sanderson (producer of the current IAP charts).

Preliminary human factors design and evaluation work on the components of what became the Volpe/ATA prototype IAP chart was accomplished at the Volpe National Transportation Systems Center under the direction of M. Stephen Huntley, Jr., Ph.D., with support from David W. Osborne, Ph.D. The work was conducted as part of the research specified in The National Plan for Aviation Human Factors and was supported by the Chief Scientific and Technical Advisor for Human Factors in the FAA's Office of Aviation Research. The prototype chart design produced by that work was further refined for air carrier operations by the ATA Chart and Data Display Working Group. Jeppesen Sanderson designed the second prototype IAP chart and drafted and printed all the many separate IAP charts used in the study. They also shared with the entire research team their knowledge gained from years of experience in aeronautical chart production.

Financial support for the contracted work in this study was provided by the FAA's Research and Development Service. Over 200 hours of simulator time, hundreds of hours of support personnel time, and 91 volunteer pilots were provided by the following ATA member airlines in the interest of increasing flight safety: Continental, Delta, Northwest, and United.

ACKNOWLEDGEMENTS

The work described in this report would not have been possible without the cooperation and assistance of numerous organizations and individuals. The authors gratefully acknowledge the support of Jeppesen Sanderson and the four participating airlines without whose help and facilities the study could not have been performed:

- ***Jeppesen Sanderson*** - Ted Thompson, Manager-Flight Information Design; Gregory L. Bowlin, Director-Airline Services.

- ***Continental Airlines, Inc.*** - Andy Larson, Management Pilot-B727, MD80; Flight Standards and Training; Jeppesen Coordinator

- ***Delta Air Lines, Inc.*** - Patricia W. Malone, Manager-Regulatory Compliance; Captain A.R. Papandrea, Manager-Flight Training Operations

- ***Northwest Airlines, Inc.*** - Doug White, Manager-Navigation Services (Chairman of the ATA Chart and Data Display Working Group)

- ***United Airlines*** - Captain Sam McWilliams, Manager-System Flight Operations; Captain Albert M. Wagner, Standards Captain DC-10; Mr. Tom Morris, System Flight Operations.

A sincere "thank you" must also be extended to the 91 pilots who volunteered for the data collection. Their interest in the research and insightful comments were a critical factor in the success of this endeavor. Our appreciation is also extended to the numerous other support personnel including simulator operators and technicians who facilitated the data collection. In addition to the authors, the study team included:

- Captain C. Edward Adams, TWA (retired), pilot/subject matter expert

- Barry J. Bassin, Dunlap and Associates, Inc.

- Charles E. Billings, M.D., protocol review

- Donald Eldredge, Battelle Memorial Institute

- M. Stephen Huntley, Jr., Ph.D., John A. Volpe National Transportation Systems Center Cockpit Human Factors Program Manager

- Captain James A. McIntyre, TWA (retired), pilot/subject matter expert

- Captain Harry W. Orlady, United Airlines (retired), pilot/subject matter expert

- David W. Osborne, Ph.D., Human Factors Psychologist, EG&G Dynatrend

- Captain Richard B. Stone, Delta Air Lines (retired), pilot/subject matter expert

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This is the final report of an evaluation of Instrument Approach Procedure (IAP) charts conducted by Dunlap and Associates, Inc. under subcontract from the Battelle Memorial Institute in Columbus, Ohio. The work was sponsored by the John A. Volpe National Transportation Systems Center (VNTSC) through their on-going contractual relationship with Battelle. The balance of this section discusses the origins of the study and the problems faced by current air carrier users of instrument approach charts. Section 2 details the evaluation methods employed and the categories of data collected. Section 3 presents the results of the evaluation. Recommendations for an improved chart are presented in Section 4. The Appendices to the report contain the data collection forms used, depictions of the charts actually employed during the study and detailed data and comment tabulations.

1.1 ORIGIN OF THE STUDY

The improvement of Instrument Approach Procedure (IAP) charts is an important part of the overall human factors efforts of the United States Department of Transportation (DOT). Because these charts deal with aviation, efforts directed at their improvement emanate from the Federal Aviation Administration (FAA). The FAA, in turn, has delegated IAP chart research to VNTSC, which has undertaken a number of initiatives, one of which is the design of an IAP chart for air carriers. The *Cockpit Human Factors Program* within the VNTSC *Operator Performance and Safety Analysis Division* is responsible for this work. The Air Transport Association (ATA) through its Chart and Data Display Working Group also has an active involvement in this program.

Air carriers operating under Part 121 of the Federal Aviation Regulations are the "major" airlines which typically operate jet aircraft into commercial U.S. and foreign airports. Although many of these companies own "regional" or "commuter" carriers operating under Part 135 or have code sharing arrangements with them, the larger operations are of primary concern. At present, virtually all U.S. air carriers use instrument approach charts produced by Jeppesen Sanderson. These "Jeppesen Charts" (or "Jepp Charts") are often customized for each airline. This customization can be in terms of added or rearranged content or can simply be a variation on chart identification and/or collation. The ATA Chart and Data Display Working Group believed that there might be significant benefits to the industry as a whole if its membership could agree on a single, standardized chart design for air carrier operations. By concentrating the chart design on the information needed for air carrier use, extraneous information currently on the charts for general aviation and other uses could be removed, thereby reducing clutter. In addition, an industry-wide upgrade would provide the opportunity to enhance aviation safety through IAP chart improvements.

VNTSC initiated the development of a prototype air carrier chart, and carried out analytical evaluation and laboratory studies. During the design of the prototype, VNTSC provided human factors guidance and performed experimental studies of readibility and speed of perception on new and/or enhanced chart features (e.g., Mangold et al., 1992). The ATA Chart and Data Display Working Group provided, in effect, "user requirements" which the design was to satisfy, along with an estimate of the extent to which air carriers and

their pilots would accept the type of changes that were being considered. Jeppesen Sanderson, as part of the working group, provided information on the realities of chart production and maintenance as well as significant insights gained from years of customer feedback.

In the VNTSC laboratory studies (e.g., Multer et al., 1990; Osborne and Huntley, 1992), the prototype chart was shown to have features that improved the readability of critical navigation and communication information as well as features that quickened the comprehension of missed approach instructions. These comparisons were relative to the current standard Jeppesen IAP chart.

The laboratory studies demonstrated that the proposed chart features had sufficient merit to warrant the production and operational evaluation of a prototype chart. The laboratory results suggested that the best evaluation would arise from a situation in which flight crews had the opportunity to try the new charts during realistic flight situations. This, in turn, suggested that moving-base training simulators along with operationally realistic techniques be used to assess the prototype. VNTSC agreed to undertake this research to compare the prototype with the current standard chart in a realistic operational setting, and the ATA Chart and Data Display Working Group member airlines agreed to provide crews and simulator time. It was the opinion of all concerned that air carriers and pilots would more readily accept conclusions of an operationally-oriented evaluation using actual airline crews than those developed only from laboratory studies.

Initially, the objective of the present study was to confirm the laboratory results for the VNTSC prototype chart in an operationally realistic environment. While initial planning was underway, the study was expanded in scope when Jeppesen Sanderson suggested the addition of a prototype IAP chart design it had developed based on comments received from users of its current, standard charts. Jeppesen also agreed to support the research by producing both of the prototype charts using its standard typefaces, paper and printing techniques and by supplying sufficient quantities of the prototypes and current standard charts.

VNTSC sponsored this research through its support contract with the Battelle Memorial Institute. Dunlap and Associates, Inc., under a subcontract with Battelle, designed and managed the study, processed and analyzed the collected data, and coordinated the development of final conclusions with VNTSC staff members. The team that carried out the research included Dunlap staff members, consultants who were experienced air carrier pilots (retired), and a member of the VNTSC support contractor staff from EG&G Dynatrend, Inc.

Initially, five air carriers (represented on the ATA Chart and Data Display Working Group) each agreed to supply 10 crews (20-30 pilots) along with enough simulator time to allow every crew to fly 10 simulated approaches. In addition, the airlines agreed to make the pilots available for about 2 hours beyond the simulator time for other evaluation procedures. Shortly after the study began, one of the airlines was forced to withdraw its offer, and the study was completed with the cooperation of four Part 121 air carriers.

Before describing the study and its evaluation results, it is appropriate to review briefly the nature of the problems encountered by commercial pilots in the use of IAP charts.

1.2 PROBLEMS IN THE USE OF IAP CHARTS

The IAP chart is the primary source of information for air crews in the conduct of instrument approaches and in the performance of missed approach procedures. IAP charts are produced for each different instrument approach to every airport runway served by air carriers. Thus, a pilot approaching a particular runway at a specific airport will have available an IAP chart for the approach type he or she has been authorized to make. This includes precision approaches, e.g., using the instrument landing system (ILS), and non-precision approaches such as a non-directional beacon (NDB) approach.

In air carrier operations, it is common for the IAP charts to be used as a reference for any approach whether or not Instrument Flight Rule (IFR) conditions prevail. It is also typical for air crews to maintain an IFR clearance even after descending into visual conditions. Thus, the IAP chart is used as a reference in virtually every approach, precision and non-precision, made in air carrier operations. Further, it is typically used throughout the approach beginning with a planning, or briefing, which may take place at en route altitude, and continuing through landing and roll-out until the aircraft is under the control of the ground controller. Since the approach phase itself takes place in a relatively short period of time and is mostly in close proximity to the ground, the crew must perform quickly and accurately. There is little margin for error. Advanced planning of the approach and clear knowledge of any contingency procedures can be extremely important during time-critical approach events.

IAP charts are used, then, when crew workload and information needs are high because of approach planning, air traffic control communication, and the actual conduct of the approach. This situation imposes a requirement that the IAP chart be designed so that the crew can quickly and accurately acquire the information presented. Since the approach phase is the final phase of every flight, the crew may be using the chart when fatigued which reinforces the need to facilitate information transfer. The crew must have access to and use such diverse information as: communications identifiers and frequencies; navigation aids identifiers, frequencies and locations; flight path information; altitude information; facilities availability, etc. There can be serious consequences if an error in information transmittal occurs during this critical flight phase.

Since the approach chart must be used in the relatively confined space of the flight deck and since the flight crew must have charts available for all reasonable alternate airports on each flight, IAP charts are currently produced in a uniform, compact size. This size and the general format were not considered candidates for change as part of the present effort. As a consequence, it can be difficult to place all of the needed information--graphic as well as alphanumeric--on every chart in a usable fashion. The information presented in words and numbers may have to be crowded into small spaces, and small type might be needed to ensure that all of the information can be shown. This is a particular problem for charts

depicting approaches at those larger, busier airports that have multiple communication and navigation facilities and many obstacles surrounding the final approach course. In some cases, just simply reproducing all of the relevant information on the standard size sheet can be a formidable task, while making the information readily accessible to the pilots borders on the impossible.

The depiction of the approach course, the runway, navaids, airports, obstacles and terrain features using graphic symbols can limit the space available for showing alphanumeric information. For charts of large, active airports, this often leads to problems such as the need to reduce character size, the absence of sufficient white space between alphanumerics or the need to overprint some alphanumerics on terrain features. When this is necessary, there can be some compromise of the quality of both the graphic and the alphanumeric information. Such compromises can affect both the speed and accuracy with which the flight crew is able to access and interpret information required for the approach.

There is a special consideration in the selection of symbols and graphic presentations because during a normal or missed approach the flight crew must be able to perceive and understand the depicted information very quickly and without error. In some normal and emergency conditions of an approach, there may be virtually no time for extensive cognitive processing. While it is possible to train pilots to associate meanings with many different symbols, each meaning-symbol association must be as direct and natural as possible. Otherwise, the time required for interpretation could become excessive relative to the time available for safe, efficient performance.

The process of information retrieval is especially difficult for the pilot flying the aircraft whose attention is directed toward the flight instruments or out of the windscreen and who may be busy with control manipulation. It is a common practice for the chart used by the flying pilot to be held with a clipboard-type fastener somewhere near the instrument panel or on the yoke or a chart table. Such locations are not always optimal for viewing by all pilots, and the flying pilot may not be free to release the chart for better viewing. Crews may compensate for this situation by a procedure in which a non-flying crew member provides the flying pilot with the needed information from a separate copy of the chart.

In summary, the IAP chart must present a substantial amount of diverse information on a limited page size using a variety of symbols and graphics as well as alphanumeric and narrative formats. The crew must comprehend this information quickly and accurately while in a moving vehicle at a time in the flight profile when their workload is already high and they possibly are fatigued. Also, stress associated with maneuvering and managing the aircraft in close proximity to the ground may adversely affect this information transfer.

2. METHOD

The method by which the evaluation of the two prototype charts was implemented is directly responsive to the objectives that were established for the evaluation by VNTSC and the study team. Therefore, this presentation of the method is prefaced by a discussion of study objectives.

2.1 OBJECTIVES

This study was conducted to determine the preferences of air carrier pilots relative to the information content and formatting of two prototype instrument approach procedure charts as compared with the current standard chart.* The fundamental measure of preference was pilot opinion of the relative utility of each of these charts, and of the unique components (defining these differences) for selected maneuvers. Specific research objectives for the pilots who participated in this study were to:

- Determine their assessment of the degree to which each prototype's new features would improve the speed and accuracy of acquiring and using IAP chart information;
- Determine their acceptance of each new or modified feature of each prototype relative to the current standard chart;
- Determine their preference among the standard chart and the two prototypes for use in an approach to an unfamiliar airport;
- Compile their suggestions for features to be included in revisions of either prototype or in a composite chart using features from both prototypes.

It should be noted that the above objectives are specifically directed at the pilots who actually took part in this study. These participating pilots were not, however, systematically selected but, rather, were volunteers recruited by their airline. It cannot, therefore, be said that the sample is representative of all air carrier pilots. It is the opinion of the research team, however, that the participating pilots do represent a range of experience and background that would justify accepting the results of this study as being a practical approximation of what would have been obtained in a study based on a rigorously defined and selected representative sample. In particular, the breadth of experience, age and operational environments represented leaves little concern that any substantial subpopulation was overlooked. The relative strength and homogeneity of the results also support the general adoption of the findings and recommendations reported herein.

---

*The term "current standard chart" is used to denote the Jeppesen instrument approach charts in use by the participating air carriers at the time of the study.

2.2 THE TESTED CHARTS

The objective of this study was to improve the speed and accuracy with which pilots can acquire the information they need from an IAP chart to make an approach and perform a go-around. Only printed approach plates similar in concept to those currently in use were considered in this study. Compatibility with advanced technologies, such as display of the approach plate information on a flight deck screen, was not a factor in the design or conduct of the evaluation. All assessments of the prototypes were referenced to the current standard chart design. An example of a current standard chart is shown in Figure 1.*

The two prototypes with which this study is concerned represent two different attempts to achieve the goal of rapid and accurate information acquisition. Both prototypes make extensive use of large and bold type to emphasize important information and to enhance legibility. Also, both prototypes have been decluttered, which is to say that information of marginal importance to the approach process has been removed or de-emphasized.

The Volpe/ATA prototype shown in Figure 2 is, perhaps, a more radical departure from the current standard chart design than is the Jeppesen prototype shown in Figure 3. The many new features of the two prototype IAP charts are described in detail in Appendix A on Protocol Forms 8J (Jeppesen prototype) and 8V (Volpe/ATA prototype). These briefing forms were used by the research team as a checklist to ensure that each of the new features was covered and that the presentation was made in a uniform manner.

The Volpe/ATA prototype includes a "Briefing Strip" which presents the information required for briefing the approach. The essential purpose is threefold: first, to identify briefing as a necessary part of preparation for an approach; second, to present the information in a logically structured format; and third, to present all of the information for a typical briefing in one place thereby avoiding the need to reference types of charts other than the IAP.

A second unique feature of the Volpe/ATA prototype is the use of icons to depict the information needed to initiate a go-around. Information depicted by icons can be perceived and understood quickly, which is essential in any situation requiring a go-around. Previous laboratory research by Osborne and Huntley (1992) had shown that iconic representations of missed approach information could be understood more quickly than and with accuracy equivalent to charts in the traditional alpha-numeric and narrative format. The present study was intended to extend the laboratory-based performance findings by exploring the receptiveness of flight crews to the inclusion of icons on IAP charts.

---

*Throughout the study, when a prototype or the current standard chart was shown as an example, the Instrument Landing System (ILS) approach to Dallas/Fort Worth International (DFW) Runway 18L was used. This was done for standardization and to avoid showing one of the six approaches that the crew would be using in the simulator.

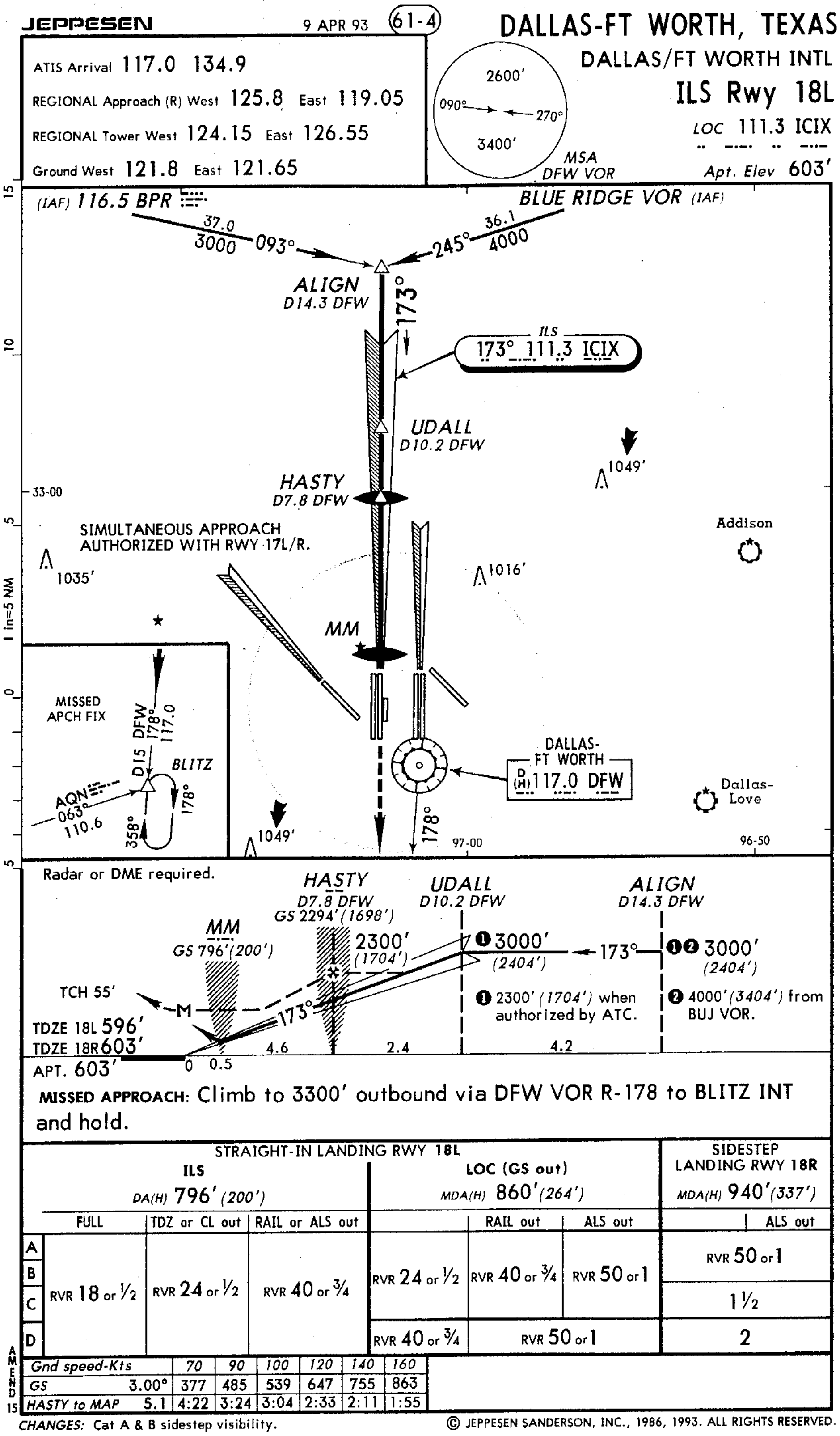


Figure 1. Current Standard IAP Chart for Dallas/Fort Worth International (DFW) ILS Runway 18L

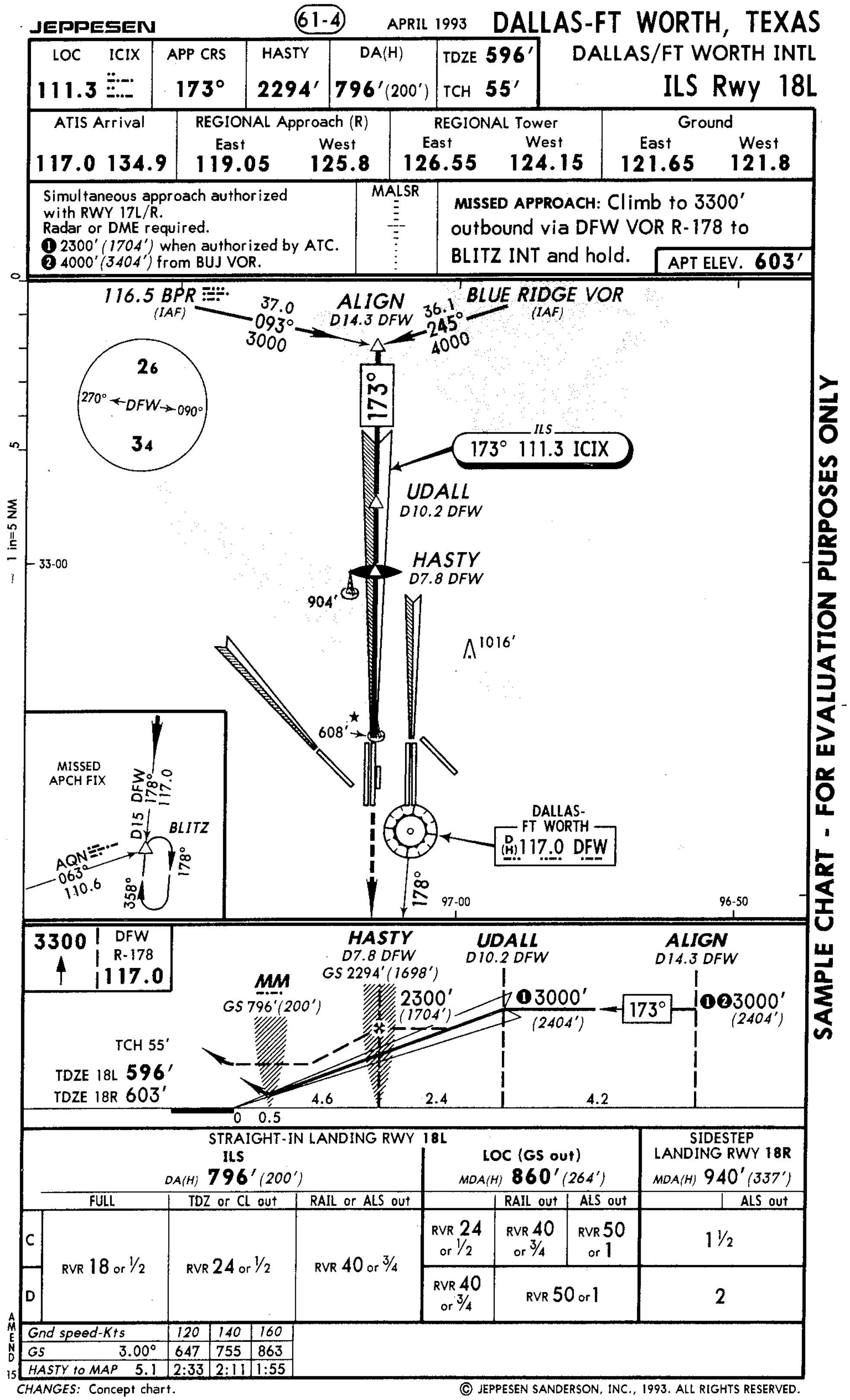


Figure 2. Volpe/ATA Prototype IAP Chart for Dallas/Fort Worth International (DFW) ILS Runway 18L

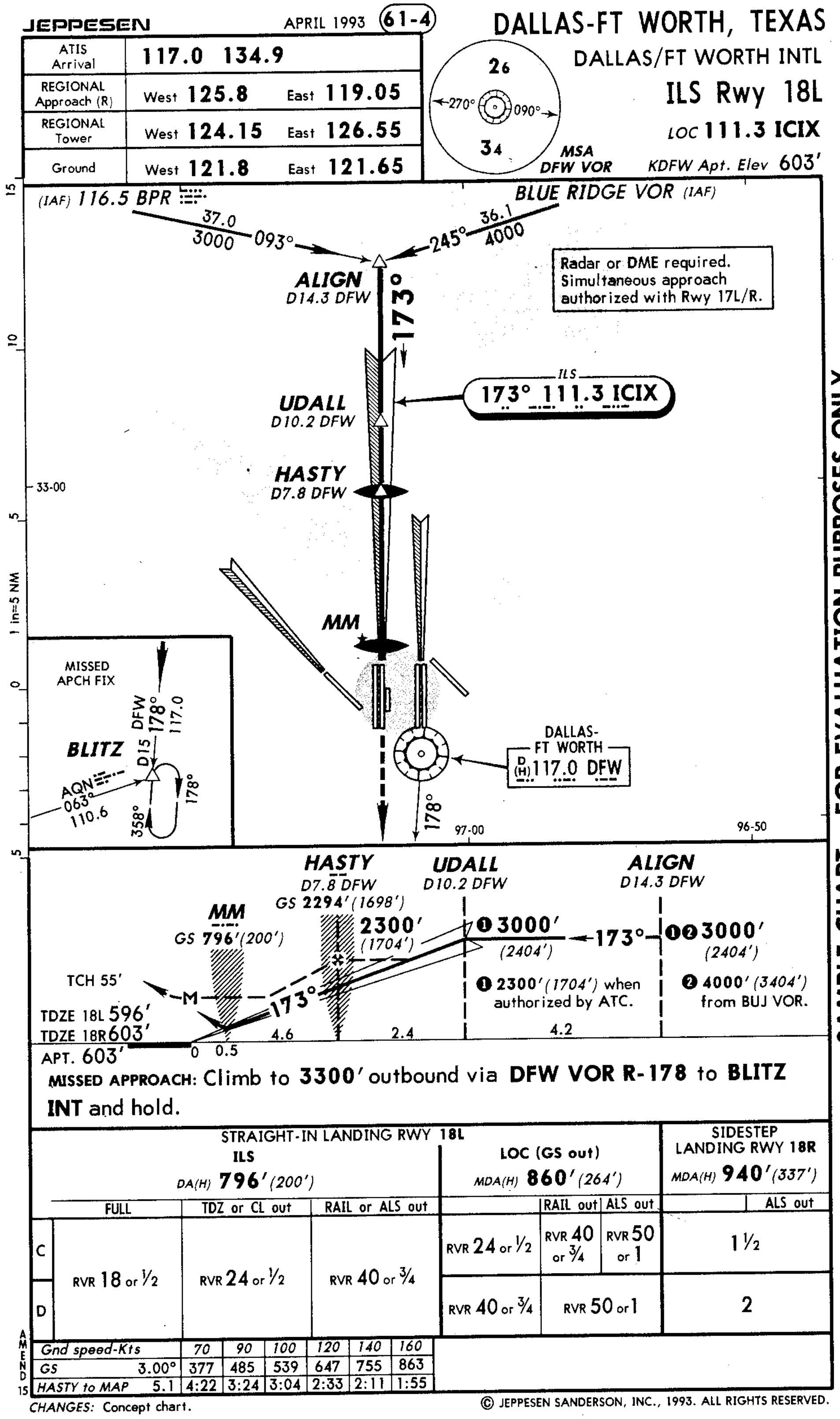


Figure 3. Jeppesen Prototype IAP Chart for Dallas/Fort Worth International (DFW) ILS Runway 18L

The Briefing Strip represents a new design based on a defined function, and the icons represent a new mode of presentation of information already contained on the current standard chart. Nevertheless, the overall format of the Volpe/ATA chart is similar to the current standard chart. It is divided into a Heading which contains chart identification as well as the Briefing Strip; a Map, or Plan View, of the approach area; a Profile depiction of the approach; and a tabulation of the applicable minimums information.

The Jeppesen prototype design adhered closely to the current standard chart design so that the transition from the current to the new design would be facilitated. The arrangement of data in the Heading is modified to facilitate the use of communication information. The chart makes extensive use of large type sizes and bolding to emphasize critical information, and to facilitate legibility. The Jeppesen prototype also includes some reformatting of items within the various chart areas to accomplish the goals of readability and decluttering.

2.3 METHOD OVERVIEW

This study included a systematic evaluation of individual design elements of each of two prototype IAP charts, one of which had been developed by the Volpe Center in cooperation with the ATA Chart and Data Display Working Group ("Volpe/ATA prototype") and the other by Jeppesen Sanderson ("Jeppesen Prototype"). It was a cooperative effort among the following:

- ***John A. Volpe National Transportation Systems Center***
  The Volpe Center developed the initial prototype chart design, defined the evaluation requirements and approach, and provided technical direction.

- ***Air Transport Association Chart and Data Display Working Group***
  The ATA Chart and Data Display Working Group provided guidance to VNTSC for the adaptation of the initial prototype design for air carrier application. ATA member airlines provided crews and simulators. The following airlines took part, and the study staff collected data at each of their training facilities:

Continental	**Northwest**
Delta	**United**

- ***Battelle Memorial Institute***
  Battelle, through its support contract with VNTSC, provided administrative oversight for the study and technical review of protocols and procedures.

- ***Jeppesen Sanderson***
  Jeppesen developed the second prototype IAP chart design and produced all of the charts that were used in the evaluation.

- ***Dunlap and Associates, Inc.***
  Dunlap designed the evaluation study and performed the data collection with a staff of human factors experts and experienced air carrier pilots (subject matter experts). Dunlap also performed the data reduction and analysis and coordinated the development of specifications for a recommended prototype chart that illustrated the application of the study results. Dunlap prepared this final report.

- ***Federal Aviation Administration***
  The FAA funded the evaluation study through its arrangements with VNTSC.

2.4 STUDY PROTOCOL

The core of this evaluation was a systematic data collection plan for gathering information from the pilots who had volunteered to take part at each of the four airlines. It was considered essential to employ a well defined protocol to ensure that each prototype received equivalent treatment and that every participating pilot received equivalent stimuli to prompt the generation of responses. Also, because the data collection schedule was determined by each airline's simulator availability, it was necessary to provide for multiple data collection teams. Obviously, a standardized protocol was essential to ensure that each team used the same procedure and did not introduce "experimental bias" by following their own interpretation of the data collection procedure.

The primary objective in the design of the protocol was to create a setting in which the participating pilots would be encouraged to think *creatively* about all of the aspects of IAP charts. Another design objective was to help each of the pilots feel free to contribute their own views and specific inputs from their experience. The protocol, in other words, was not to be used as a guide for a specific question-and-answer exchange but rather as a standardized discussion framework to facilitate the collection of each pilot's opinions and specific inputs concerning the use and the design of IAP charts.

As a first step in meeting these objectives, it was decided to structure the protocol in a way that reflected the functional parts of the current IAP charts (Heading, Plan View, Profile View, Notes, etc.). Since this structure coincides with the way in which pilots read and use IAP charts, it should facilitate their recall of specific inputs for each functional section of the chart.

The structure of the protocol was also shaped by the fact that every chart feature can be thought of as having two attributes: content and format. "Content" refers to *what* the feature depicts, and "format" to *how* it is depicted. By emphasizing these two aspects, the protocol led the pilots to concentrate separately on what is shown and how it is shown. This helped to ensure that: 1) the pilots considered all of the IAP chart functions, as represented by content; and 2) they referred to their experience in reading and understanding the depiction of the information elements of the chart.

The concepts of content and format relative to each element of the IAP chart were introduced early in each data collection session. The introductory stage of the data collection was used to assess the pilots' estimate of how much opportunity they saw for improvement in the current charts with regard to content and with regard to format. The pilots were briefed on these concepts before they made their estimates, and the research team probed to ascertain if the estimates of change potential were fully applicable to both content and format of all parts of the chart.

Finally, the separate focus on content and format is reflected in the basic structure of the entire study. This study was developed as essentially a human factors investigation supported by professional pilot expertise which is reflected in the assignment of a human factors specialist and an expert Part 121 air carrier pilot to each research team. The research issues related to *format* are human factors concerns, while those related to *content* are operational concerns. The former are, of course, the responsibility of the human factors specialists while the latter are the concern of the expert pilots. This distinction is reflected in the division of research activities throughout the protocol. For example, the expert pilots were the source of virtually all of the observational input from the simulated approaches, and the human factors specialists led the collection of the scaled judgements of prototype features. The pilots concentrated on how the charts were used and the human factors specialists focused on how the pilots responded to the various methods of information presentation.

It should be noted, however, that this division was not totally exclusive. Both members of each research team took part in every activity defined in the protocol. Each team member took the lead in those activities which were mainly concerned with his specialization. This joint, cooperative approach was stressed in the research team training at the beginning of the study and apparently worked well throughout the study.

2.5 PROTOCOL IMPLEMENTATION

Two or three pilots (as appropriate to the simulator being used) took part in each data collection period as a "crew" and completed their part in the study in a single session. The study staff was represented by a research team consisting of a human factors specialist and an expert air carrier pilot. Several techniques were used to capture the pilots' opinions and reactions to the content and format of the prototypes. A large part of the information, however, came out of group discussions among the crew and the study staff. It was because of this emphasis on interactions between participants and researchers that both human factors and pilot expertise were essential on the study teams. It was reasoned that the expert pilots would focus primarily on content issues based on their extensive experience using IAP charts. The human factors researcher with aviation experience, on the other hand, was in an ideal position to filter format issues based on sound human factors principles. All sessions were held privately in briefing rooms at the airline training centers so that the pilots would feel free to express their preferences. Data collection took place during the late spring and early summer of 1993.

Throughout the study, the two prototypes were referenced to the current standard IAP chart as the basis for comparison and to stimulate discussion of IAP chart features. All three charts were also used in flying the simulated approaches, although each crew used only one prototype and the standard in the simulator. To avoid any indication of preference, the study team kept their comments free of any words or attitude that might bias the crew or suggest that there was a "correct" or "expected" reaction to any of the three charts. The entire methodology was designed so that each prototype would be given equal consideration. It is the opinion of the study team that this objective was achieved.

Except for a small number of equipment failures, each pilot had the opportunity to use one of the prototype chart designs in flying simulated approaches. In some of these approaches, the simulator operator called for a "go-around" as scheduled in the study design to allow evaluation of that aspect of IAP chart use.

At all times, the pilots were reassured that the study was in no way an assessment of their performance and that the information being recorded concerned only how well the charts supported the conduct of approaches and "go-arounds." The research teams strived to make each meeting very open and free of anything which might be perceived as limiting what could be said. In each meeting the pilots were encouraged to be creative in their thinking about chart features, especially about possible changes to the prototype designs. The pilots were told that the prototypes were to be considered as illustrations of some new ideas and open to any suggested revision or modification. The pilots were also assured that the researchers were not the chart designers and therefore had no vested interest in the outcome of the study.

The design of the study procedures began by identifying the kinds of information needed for a complete and valid evaluation and then proceeded with developing techniques for collecting the information. The result was a seven part protocol that was completed in a single four to five hour session with each of the crews. The study protocol included directions for the research team to conduct each activity, handouts for the crew and record sheets for crew responses and team comments. Some modest refinements were made in the protocol following a trial run. The final form of the protocol is reproduced in Appendix A.

The entire session in the crew briefing room was recorded with a video camera, except for the Introduction during which the crew's consent for participating and making the video record was obtained. The simulator sessions were also video recorded in those simulators which were equipped with cameras for use in Line-Oriented Flight Training (LOFT) scenarios. The primary purpose of these recordings was to obtain a record of the comments made by the pilots without the need for the data collection team to be distracted by extensive note taking. The video also permitted the documentation of ideas that were expressed as sketches or gestures or were pointed out on poster-sized reproductions which were displayed when briefing or debriefing each of the charts. The video, however, was of only limited value during the simulator sessions because LOFT camera installations reveal relatively little of the cockpit. Also, the audio quality tended to be poor during this study since the headset-mounted microphones were not generally used.

The data collection process consisted of seven parts which flowed together as shown in Figure 4. The seven parts included:

- ***Introduction*** - This was an essentially administrative activity which involved explaining the study and obtaining the pilots' consent to proceed. It included asking the pilots for information about their flight experience and for their opinion of the potential for improvement of current IAP charts.

- ***First prototype briefing*** - The prototypes were alternately assigned to be considered first. The research team described those features of the first scheduled prototype which differed from the current standard chart.

- ***Simulator session*** - Each crew was scheduled to fly 10 simulated approaches using one of the prototype chart designs and the current standard in a counterbalanced arrangement. Completed approaches as well as "missed approaches" or "go arounds" were performed, again according to a counterbalanced plan.

- ***First prototype debriefing*** - After the crew used the first prototype in the simulator, a debriefing was held in which the crew's evaluation was obtained. Scaled quantitative responses as well as qualitative comments were obtained. Upon completion of the debriefing, all copies of the first prototype were removed from view.

- ***Second prototype briefing/debriefing*** - The second prototype was then introduced and displayed for this session which included briefing and debriefing only. Time did not permit a simulator session for the second prototype.

- ***Direct scaling*** - Both prototypes and the current chart were ranked relative to each pilot's opinion of their usefulness in planning and executing an approach and in making a go-around. It is the first place in the protocol in which all three chart forms (both prototypes and the current standard) were viewed simultaneously and compared.

- ***Decision-to-Buy*** - This exercise included two activities. First, each pilot was asked to assume that he or she was individually responsible for recommending an IAP chart to be purchased and used by all pilots working for his/her line. The choice was made from among the two prototypes and the current standard chart. No discussion among crew members of the contemplated choice was permitted. Then, the crew was asked to make a ***joint*** decision in the same way. During this decision-making, interaction among crew members was encouraged. At the end of this session, a general discussion of the reasons for the various decisions was held.

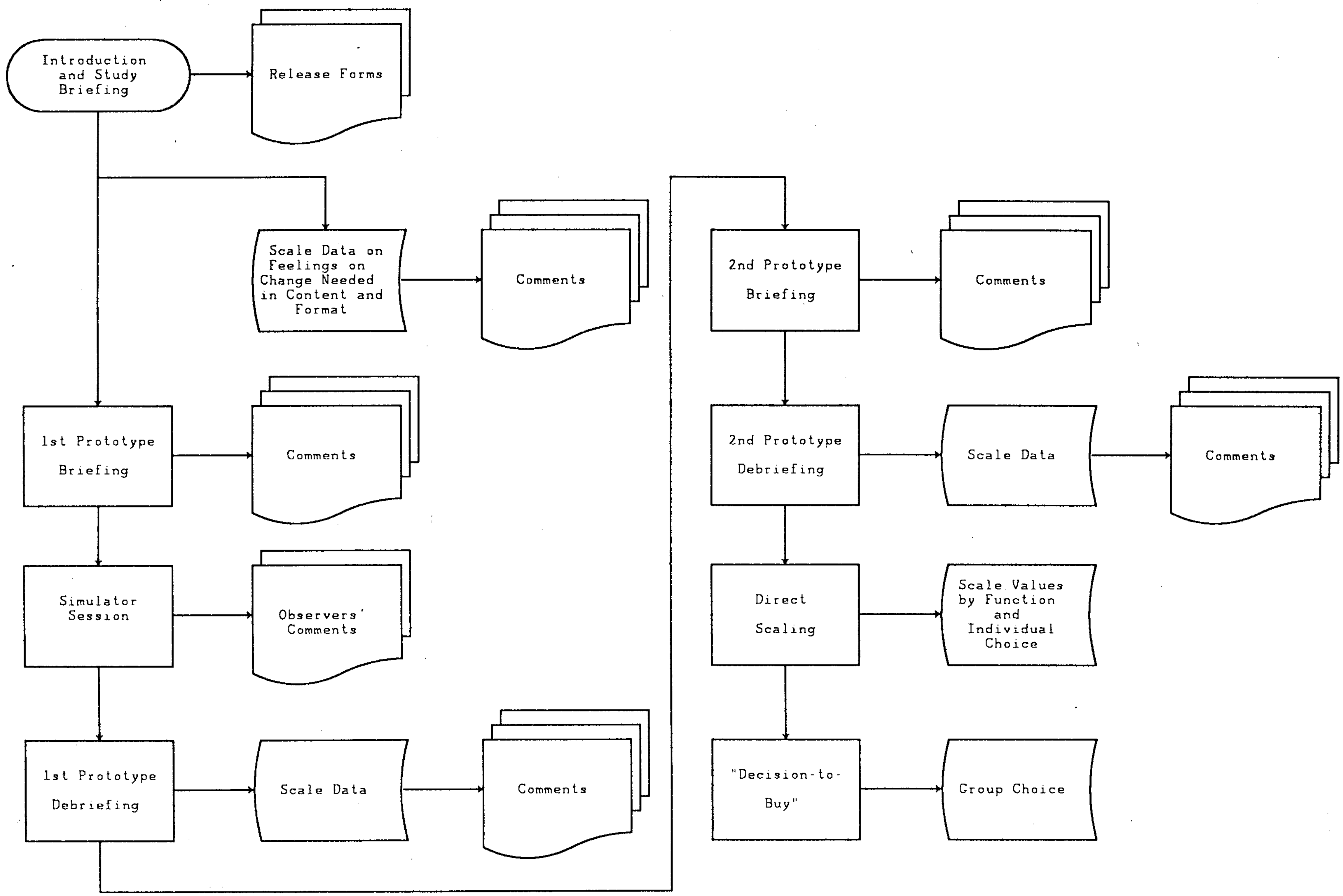


Figure 4. Data Collection and Processing Flow

2.6 METHOD DETAILS

The study protocol was based on the premise that research teams made up of a human factors specialist and an experienced air carrier pilot would be formed and assigned to the participating airlines as needed to meet the simulator schedule established by each airline. Based on these schedules, four such teams were established. Three of the human factors specialists were regular members of the Dunlap professional staff. One came from EG&G Dynatrend, a support contractor to VNTSC. All four were experienced in the collection of the types of data sought in this study and had conducted previous human factors research in an aviation environment. The four pilots were retired airline captains recruited by Dunlap; they each had experience in research and consultation following their retirement and had previously focused on human factors issues as part of their airline or consulting work.

The first data collection was conducted at Delta Airlines and was attended by all of the research teams. It consisted of three separate activities. First, the members of the research team were trained in the use of the protocol. The focus of the training was to ensure that each team applied the various data collection forms in the same manner. Second, the protocol itself underwent preliminary testing with four crews (one crew by each team). The basic protocol proved highly workable, and therefore only minor changes were made after the pilot test. Finally, the four teams participated in the collection of data from 10 Delta crews. The schedules at each of the other three airlines were such that two research teams had to be assigned to each in order to cover simultaneous, or overlapping, simulator schedules. Data collection at United Airlines was accomplished by two teams immediately after the completion of the Delta effort. Activities at Continental and Northwest took place about a month later.* Approximately seven days were spent at each airline.

2.6.1 <u>Introduction</u>

The introduction with each crew was intended to acquaint the crew with the study staff and accomplish some administrative tasks, including obtaining their formal agreement to participate. It also provided for collection of two important sets of data. First, the pilots were asked for some specific information about their qualifications and experience, which was given anonymously but could be associated with all of their other quantitative responses. This was used to describe the group of pilots in the evaluation and to categorize some of the collected information. The second set of information was a scaled opinion (given by each pilot separately) of the degree to which the current standard IAP chart could be improved. Separate opinions were requested with regard to the information content of the chart and the formats used to present the information. This scaled information was used to gauge the pilots' willingness to accept changes in the IAP chart. A poster-sized reproduction of the

*Data were collected in the preliminary test using essentially the same procedures as were used in the main study. Therefore, these data have been included in the study results without differentiation.

current chart was displayed for reference throughout this session. The crew also had actual copies of that chart for reference. This session concluded with a brief description of the study and its objectives. Protocol Forms 1 through 7 shown in Appendix A describe this part in more complete detail.*

2.6.2 First Prototype Briefing

This session included a detailed briefing on one of the prototypes by the research team. The Volpe\ATA and the Jeppesen prototypes were used alternately in this first session so that about half of the crews were briefed first on each prototype. This was also the prototype with which they would fly in the simulator during the next protocol step. While it would have been ideal to have given every pilot the opportunity to use both prototypes in the simulator, the practical constraints of simulator and crew availability as well as researcher and crew workload precluded this.

At the conclusion of the introduction, the research team distributed copies of the selected prototype chart and displayed a poster-sized reproduction of it. The samples of the current standard chart used in the introduction remained in view. Actual-sized prototypes printed by Jeppesen Sanderson on their standard paper, as well as a larger version (8½ by 14 inch; 21.59 cm by 35.56 cm), were distributed to each participant. The former permitted the pilots to see a depiction of the prototype in a size and format comparable to the charts they were accustomed to using. The latter provided an enlargement for clarity and a place for jotting notes or depicting suggestions. Figures 2 and 3 show, respectively, the Volpe/ATA and Jeppesen prototype versions of the DFW Runway 18L instrument approach chart used during the briefing.

After the prototype chart examples were distributed and the poster-sized chart displayed, the study team described the chart emphasizing those features which differed from the current standard. This briefing included a discussion of the rationale for each of the new features as provided by the two prototype developers. The crew was allowed a question period and enough time to become comfortable in the use of the prototype in the simulator session which followed this briefing. Care was exercised to ensure that no bias was conveyed when responding to questions concerning the rationale or purported utility of any of the prototype features. It was also made clear to the crews that the "prototype" was, in fact, a compendium of proposed design features rather than a finished product. The stated purpose of combining the various features into a coherent prototype was to produce a chart capable of being used during the simulations so that the pilots could gain "hands-on" experience. The crews were purposely kept unaware that a second prototype existed and that they would be asked to evaluate it after they completed their simulated approaches. This was done to avoid having the crew limit their assessment of the first prototype until the second had been evaluated.

---

*Form numbers appear at the bottom of each page in Appendix A.

2.6.3 Simulator Session

There was a brief break while the crew and the research team went to the simulator and set up for the simulated approaches. The simulator operator was given the schedule of approaches to be flown, and the crew prepared to fly the simulator. The pilot member of the research team typically observed the crew from the jump seat position so that he could be close to the crew to record his assessments of the use of the chart and how it affected the crew's acquisition and use of information. The human factors team member was generally seated at one of the instructor's consoles and also observed the crew to record his perceptions how well the chart transferred information.

Six different approaches were flown during the simulator sessions:

- Chicago O'Hare International (ORD) ***ILS*** Runway 14R
- Denver Stapleton International (DEN) ***ILS DME-1*** Runway 8R
- Los Angeles International (LAX) Runway ***ILS*** 24R
- Chicago O'Hare International (ORD) ***VOR*** Runway 22R
- Denver Stapleton International (DEN) ***NDB*** Runway 26L
- Los Angeles International (LAX) Runway ***VOR*** 25L/R*

These approaches were arranged in blocks of 10 for each session. The blocks were created by cycling through the six approaches so that one crew would fly numbers one through six and then one through four. The next crew would then begin its block of 10 with approach number five. If a "crew" included two pilots accustomed to flying from the left seat, e.g., instructor or check pilots, one pilot flew five consecutive approaches from the left seat and then exchanged seats so the second pilot also flew from the left seat. Regular line crews (captain and first officer) or similar crew pairings flew from the seat to which they were most accustomed and alternated approaches as is typically done on consecutive legs of a line trip.

The first and the last approach flown by each pilot was with the current standard chart; the other approaches were flown with the prototype on which they had just been briefed. Each approach commenced at approximately 5,000 feet (above ground level) after the crew had briefed the approach using as much time as they considered necessary. Crews were also permitted discretion in the use of the available aircraft automation. The simulator operator requested the crew to make a "go around" on five of the 10 approaches according to a schedule in the protocol which counterbalanced the altitude at which the call was made and the approach in which it was made. Three of the "go arounds" were scheduled to be initiated at well above the charted minimums in order to give the crew experience in reading more than just the basic "up and out" maneuvers in the published missed approach procedure. The remaining two were planned to take place at or near the minimum altitude for the particular approach being flown. The simulators were set for calm winds, no aircraft

---

*ILS = Instrument Landing System; VOR = VHF Omni-Directional Range; NDB = Non-Directional Radio Beacon. These terms describe the navigation aids available to assist a pilot on the specified approach.

failures and a runway visual range of approximately 2,500 feet (762 meters). A night visual scene was depicted.

2.6.4 First Prototype Debriefing

Upon completion of the simulator approaches, the crew and research team returned to the briefing room and went through a debriefing in which the crew gave its evaluation of the prototype. A question list including one item about each new feature on the prototype was used. The list for the Volpe/ATA prototype consisted of 17 questions, 15 to be answered using a six point scale and two to be answered "yes-no." The Jeppesen prototype list was made up of 16 questions using the same six point scale. The Protocol forms numbered 14 (J or V) as shown in Appendix A were designed for use in this session.

The requests for scaled responses on the various chart features were preceded by the following prompt:

> *Compared to the current Jeppesen-type chart, how much better or worse does each of the following features make the prototype?*

The scale was reproduced on an answer sheet which showed that a judgement of "Significantly Worse" was represented by "1" and "Significantly Better" by "6." The participating pilots were instructed to answer each question independently--not as a crew. After each question had been answered by all of the crew, the pilots were each asked to present and discuss the basis for their response. This discussion was recorded by the video camera and by the research team using prepared forms. Discussion of the prototype feature, including especially ideas about its enhancement, was encouraged. The crew was allowed to continue this discussion until they felt that they had expressed all of their ideas.

2.6.5 Second Prototype Briefing/Debriefing

The briefing of the second prototype and the debriefing which followed immediately afterward were conducted in exactly the same way as described above for the first prototype session. The crew did not fly the simulated approaches in this session. They were, however, requested to reflect on their experience with the other prototype in the simulator as they made the scaled response of the degree to which each feature made the second prototype better or worse than the current standard chart. Discussion of the prototype and of new ideas it generated was encouraged, as in the first prototype session. Protocol Forms 8 (J or V for briefing) and 14 (J or V for debriefing) were also used for these sessions. The prototype used in the first session and flown in the simulator was removed from view while this second briefing and debriefing were underway. This was done to foster comparisons only with the current standard chart rather than between the two prototypes or among all three versions.

2.6.6 Direct Scaling

This session was concerned with a direct comparison among the two prototypes and the current standard charts. Protocol Form 15 shown in Appendix A was used to guide this exercise. Each crew member was requested to make this evaluation independently without consideration of what the other member(s) did. The instructions were to think of being in a situation in which an approach was to be made to an airport which was not familiar: one which was new to the pilot, or one to which he/she had not recently made an approach. Further, the directions were that separate evaluations were to be made of using the chart in briefing the approach, of using it during a normal approach, and of using it to perform a go-around.

The pilots were provided with laminated actual-sized copies of each chart that incorporated an arrow on the bottom edge. A 35 inch (88.90 cm) scale (similar to a yardstick) having a marked range of 0 to 100 was placed in front of each pilot. The scale points for zero, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 were equally spaced and labeled. An unlabeled tick mark was placed halfway between each marked division. For each function (briefing, normal approach, missed approach), the chart that was judged best was to be placed on the scale with its arrow aligned to the value that represented the pilot's judgement of its value to the function being scaled. Then, the other two charts were to be placed on the scale with their arrows aligned to the point on the scale that represented their value relative to the "best" chart. Charts could be overlapped to indicate a judgment of identical or nearly identical values.

This version of the direct scaling technique has been shown to be superior to other psychophysical methods of quantifying subjective estimations in this type of task (Osborne, 1988). This direct scaling method allows people to quantify how much of a characteristic one item in a sample set possesses relative to other items in the set, and along a separate absolute scale. In this study, each chart's placement along the scale clearly quantified how much better or worse it was relative to the other charts, and where it was along the absolute scale for that characteristic (e.g., the chart's acceptability for executing an approach). For example, if a pilot thought that all the charts were very good for executing an approach, he or she would place all the charts near the high end of the scale, and reflect the relatively small subjective differences between them by slightly separating their locations along the scale.

The research team recorded the scale point at which each of the charts was placed for each of the functions, interpolating as necessary between marked points. For each pilot, the direct scaling resulted in nine separate data values (3 chart types x 3 flight functions).

2.6.7 Decision-to-Buy

At the end of the direct scaling process, the pilots were asked to engage in "role-playing" as described in Protocol Form 16 in Appendix A. First, each crew member, working alone, was asked to imagine that he or she had been given the responsibility of recommending a single IAP chart type to be purchased by his or her company for use on

all of its routes. It was to be assumed that there was no difference in the costs of the charts and that training, if needed, could be accomplished at no cost (or at no different cost among the three charts). The pilot made the choice by handing one of the three laminated charts used in the direct scaling exercise to one of the researchers who recorded the decision.

Next, the choices of the crew members were announced by the research team. The crew was then asked to compare the choices they each had made and imagine that as a committee they had to agree on a joint recommendation concerning which chart would be flown by everyone at their airline. The assumptions of cost, etc. were the same as for the individual selections. They were requested to discuss their choices and "talk their way" through the process of arriving at a consensus. The video camera recorded this process and the research team made notes. The research team recorded the final selection made by the crew. Obviously, if their individual decisions to buy concurred, this process was shortened considerably. Nevertheless, even in cases of complete agreement, the crew members were encouraged to voice their rationale for recommending to their managements the chart design they had chosen.

This exercise was intended to lead each pilot to consider the value of each chart when used by pilots other than the individuals taking part in the study. The evaluation up to this point requested the pilot/crew opinion of how well each of the charts met their own flying needs. The "decision-to-buy" forced the consideration of how the chart would suit other pilots (presumably of differing degrees of experience and qualifications) and the variety of airports served by the crew's line.

2.7 DATA ANALYSIS

The application of the method just described resulted in an extremely large and rich set of evaluation information. The available data included quantitative results as well as numerous comments and suggestions elicited from the crews. Before discussing the analyses conducted and the results themselves, it will be useful to the reader to have an appreciation of the kinds of data that were available to the project staff for evaluating the various features.

Ninety-one pilots participated in the study. Of these, 10 did not fly the simulated approaches because of equipment problems. These 10 pilots were introduced to each prototype in the same way as the other 81. They were then asked to think about actually using the prototype to fly an approach or a missed approach and to respond to the debriefing items in terms of how they thought the prototype would support them. Their data were segregated during the analyses. In addition, data were examined separately as a function of which prototype chart had been used in the simulator. Simply, it was reasoned that actually flying with a prototype would provide a crew with far greater insights into its potential utility than merely reviewing it in a briefing room. As will be seen below, this assumption proved valid as indicated by the marked differences in preference and comments as a function of which prototype was actually used by a respondent.

The quantitative data collected were subjected to a variety of cross-tabulations and numerical comparisons. Comments were extracted from the video and the paper and pencil records by staff researchers to facilitate interpretation.

The following paragraphs describe the data that were collected and processed in preparation for the derivation of results and recommendations. Each paragraph characterizes the data and references the Protocol forms and the analytical techniques that were employed.

2.7.1 Introduction

The introduction yielded several items of classification data from the Background Information form (Form 4-1). These included:

- Total flight hours
- Whether or not the pilot was Air Transport Pilot (ATP) qualified
- Current type qualification
- Hours in current type
- Other aircraft qualifications previously held
- Whether the pilot had flown a single pilot Instrument Flight Rules (IFR) approach in the last 6 months
- The percent of all approaches flown in the last 6 months which were executed with:
  - NOS charts
  - Military charts
  - Jeppesen Charts.

The purpose of collecting this information was to describe the population of pilots whose opinion had been solicited and to see if there were any major systematic differences as a function of pilot characteristic or flight experience within or outside the airline. This information was used to form subgroups for cross-tabulations.

The introduction also contained two questions with associated six point response scales which addressed how much (from *Very Little* to *Very Much*) the pilot thought current Jeppesen-type approach plates could be improved by changing their ***content*** (i.e., the kind and amount of information they contain) or their ***format*** (i.e., the way information is presented). These scales were included for three purposes. First, they documented the extent to which the respondent felt the need for IAP chart changes ***before*** being exposed to any of the features of the prototypes. Second, they served to introduce the content/format

distinction which was carried throughout the protocol. Third, they began the process of having the respondent work with the scaled response format which would be used extensively in the subsequent debriefings. The responses to these initial scales, particularly in juxtaposition to pilot reactions after exposure to the prototypes, was particularly interesting.

2.7.2 Prototype Briefings

The research team described the Volpe/ATA and Jeppesen prototypes to the pilots following the checklists presented in Forms 8V and 8J, respectively. During this briefing process, questions and discussions were encouraged. Comments were recorded and content analyzed for implications for chart changes or additions.

2.7.3 Prototype Debriefings

The data for the debriefing of the Volpe/ATA prototype was collected on Form 14V-4 based on the questions read by the research team from Forms 14V-1 through 14V-3. The recorded values are scaled responses made to the first 15 items which covered each feature of the prototype that differed from the current standard chart. The last two items were concerned with the inclusion and formatting of "circle to land" information on the chart and were asked in a manner to elicit a binary ("Yes/No") response. Similar data for the Jeppesen prototype consisted only of the 16 scaled items contained on the various components of Form 14J.

The first analyses of the scaled data were cross-tabulations of each response as a function of "chart flown" as well as some of the other salient classification data such as experience level and airline. In general, only chart flown resulted in meaningful differences. In particular, airline worked for and flight experience (both length and aircraft type) did not produce notable differences in response.

An inherent problem in the use of rating scales is the possible differential use of the scale across respondents. Some people use all of the available scale values. Others will truncate the scale at one end (either high or low) or eliminate the extremes and just use the center points. These biases in the use of the scale have the potential to mask real response differences. Therefore, in order to examine the responses to the scales free of biases inherent in the use of the scales, two data transformations were calculated. The first was a standard Z-score transformation which was calculated for each pilot by subtracting the mean of his or her ratings from each rating score and dividing the resultant by the standard deviation of all of his or her scores. This standardized an individual respondent's ratings on all of the scales used in the study to a mean of zero and a standard deviation of one.

The second transformation was a range transformation following the approach suggested by Gopher and Braune (1984). This was formed by subtracting a respondent's minimum scale value used from each rating and dividing by the overall range of ratings (maximum minus minimum). This type of transformation is more suitable to restricted range data, such as a six point scale, than is the traditional Z-score. In fact, however, both the Z-score and range transformation as used in this study led to identical results. Further,

although both transformations were made to compensate for possible idiosyncratic application of the six point scale, examination of the results indicated that the simple tabulations of the raw ratings yielded the same conclusions as the analyses of the transforms. Therefore, only the raw data are presented in the body of this report. For completeness, however, Appendices C and D contain data on the calculated transformations as well as cross-tabulations of the raw rating scores.

2.7.4 Crew/Observer Comments from Simulator Sessions

These data were collected using Forms 12 and 13, and have been compiled separately for each of the six approaches that were flown in the simulators during this study. They are reported in detail in Appendix E and discussed in the context of each feature in the next section. Some of the comments have been paraphrased to ensure understanding, and each comment is reported only once regardless of how many times it was raised. Comments are identified by the chart that was being used in the approach (Volpe/ATA prototype, Jeppesen prototype or the current standard chart). This information is qualitative in nature and forms a reference for the interpretation of results.

2.7.5 Volpe/ATA Prototype Debriefing Comments

This data set is a compilation of the comments made by the crew members while they were making the scaled responses to the debriefing of the Volpe/ATA prototype. The comments were extracted from the video record of the debriefing and from the notes made by the researchers during the session. They are reported in detail in Part 2 of Appendix C and are discussed in Section 3, Results. They may have been paraphrased, and each comment is reported only once. Comments are organized by the item to which they refer. These are not quantified, but provide background for interpretation.

2.7.6 Jeppesen Prototype Debriefing Comments

This information is identical to the data for the Volpe/ATA prototype except, of course, that it refers to the Jeppesen prototype debriefing. A detailed listing of the comments is contained in Part 2 of Appendix D, and the salient comments are discussed for each feature in Section 3, Results.

2.7.7 Direct Scaling Comparison/Decision-to-Buy

These exercises resulted in direct scaling information as well as individual and crew preferences. Since each pilot only provided nine direct scaling values (3 charts x 3 functions), no normalization of data was considered appropriate. However, in addition to examining the numeric values given in the direct scaling exercise, the relative ranking of the three chart types was also analyzed. This was an additional post-hoc preference measure on a function-by-function basis (briefing the approach, executing the approach and executing a go-around).

3. RESULTS

The results of this study consist of the comments obtained from the pilots about individual approach chart features augmented by quantitative results from analyses of the several scaled responses which the pilots gave to questions about specific design features of the two prototype charts and the current standard chart. Together, the comments and the quantitative values are the major basis from which the project staff derived the Detailed Recommendations for approach chart design contained in Section 4.3 of this report. Before presenting the feature-by-feature results, however, it is of interest to examine two other aspects of the data. The first deals with the characteristics of the respondent population, and the second presents the results of the direct scaling/decision-to-buy exercises.

3.1 RESPONDENT POPULATION

As discussed in the previous section, the sample of pilots for this study was drawn from four cooperating air carriers. No attempt was made to obtain representation of the overall air carrier pilot population. Rather, an opportunity sample of experienced aviators was obtained. These pilots were then randomly assigned to fly simulated approaches with one of the two prototypes. While the respondent population was not intended to be representative, it is still of interest to examine their characteristics to determine if there were major differences among those who flew their simulated approaches using the Volpe/ATA prototype, those who flew with the Jeppesen prototype and those who did not fly at all due to simulator problems.

Table 1 shows total flight hours for the 91 pilots who provided data for the study. Of these 91, 37 were briefed on the Volpe/ATA prototype first and used it in the simulator. Forty-four pilots were briefed on the Jeppesen prototype first and flew their approaches with it. The higher number who flew with the Jeppesen prototype resulted from the random mix of two and three person crews. Ten pilots did not fly any simulated approaches. Five of these pilots were briefed on the Volpe/ATA prototype first, and the remaining five saw the Jeppesen prototype first.

It can be seen clearly in Table 1 that the pilots in the study had considerable flight experience. Over 50 percent reported more than 10,000 total hours with almost 21 percent reporting in excess of 15,000 hours. It can also be seen that there was no significant difference in total flight hours between the group of pilots which flew with the Volpe/ATA prototype and the group which flew with the Jeppesen prototype.

Most of the pilots in the study held a current type-rating. In general, each pilot's rating was for the same aircraft type as the simulator which he or she flew during data collection. Table 2 shows the distribution of simulator types used during the study. The range is from relatively older, low automation types such as the Boeing 727 and McDonnell Douglas DC-10 to high automation aircraft such as the Airbus A320 and Boeing 747-400. This provided a good representation of prevailing aircraft types and type ratings among the pilot respondents.

Table 1. Total Flight Hours by Chart Flown

Chart Flown	Total Flight Hours					Total
	2,500-4,999	5,000-7,499	7,500-9,999	10,000-14,999	15,000+	
Volpe/ATA	1* 2.7%**	6 16.2%	7 18.9%	11 29.7%	12 32.4%	37 100.0%
Jeppesen	4 9.1%	9 20.5%	8 18.2%	16 36.4%	7 15.9%	44 100.0%
None	3 30.0%	3 30.0%	1 10.0%	3 30.0%		10 100.0%
Total	8 8.8%	18 19.8%	16 17.6%	30 33.0%	19 20.9%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 4.13 with 4 d.f., n.s.)

In this and all following tables, the Chi-square value is based ***only*** on those pilots who actually had the opportunity to perform simulator trials with a prototype (the "Volpe/ATA" and "Jeppesen" rows in the tables). A Chi-square value is reported as non-significant (n.s.) if the associated probability is 0.05 or greater.

Table 2. Simulator Type Used by Chart Flown

Chart Flown	Simulator Type									Total
	DC-10	747-200	747-400	757/767	A320	727	737 Glass	737 Std.	MD-88	
Volpe/ATA		2* 5.4%**	5 13.5%	4 10.8%	2 5.4%	8 21.6%		6 16.2%	10 27.0%	37 100.0%
Jeppesen	9 20.5%	2 4.5%	1 2.3%	2 4.5%	2 4.5%	8 18.2%	2 4.5%	10 22.7%	8 18.2%	44 100.0%
Total	9 11.1%	4 4.9%	6 7.4%	6 7.4%	4 4.9%	16 19.8%	2 2.5%	16 19.8%	18 22.2%	81 100.0%

*Entry is number of pilots
**Percent is of chart flown

Almost half of the pilots who participated had between 1,000 and 3,000 hours of experience in their current aircraft type as shown in Table 3. Many had in excess of 3,000 hours in type while only about 30 percent of the respondents had fewer than 1,000 hours in

type. The pilots were also asked what other type ratings they had held in their careers, and the resulting list was extensive. Almost every major civilian and military aircraft type was represented. This provides confidence that the opinions expressed were based on experience in the full range of aircraft types in which an air carrier version of instrument approach charts would be used.

Table 3. Flight Hours in Current Type by Chart Flown

Chart Flown	Flight Hours in Current Type				Total
	< 1,000	1,000-1,999	2,000-2,999	3,000+	
Volpe/ATA	10* 27.8%**	8 22.2%	7 19.4%	11 30.6%	36 100.0%
Jeppesen	12 28.6%	13 31.0%	11 26.2%	6 14.3%	42 100.0%
None	4 44.4%	1 11.1%	2 22.2%	2 22.2%	9 100.0%
Total	26 29.9%	22 25.3%	20 23.0%	19 21.8%	87 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 3.29 with 3 d.f., n.s.)

Experience with a Flight Management System (FMS) is another factor which could theoretically influence a pilot's opinions with respect to approach chart design. The FMS data base contains much of the information which a pilot normally obtains from a paper chart. In this study, a pilot was considered to be FMS experienced if he or she had ever been qualified in an FMS-equipped aircraft type. Table 4 shows the proportion of respondents who were judged to have FMS experience. It can be seen from Table 4 that more FMS experienced pilots flew with the Volpe/ATA prototype than with the Jeppesen. Cross-tabulation analyses of all of the chart preference measures by FMS experience, however, indicated that FMS experience was not statistically significantly associated with any chart preference measure. In the tables which follow, therefore, tabulations of study data are shown only by "chart flown."

As part of their introduction to the study protocol, the participating pilots were asked for their impressions of the improvement possible from content and format changes to the existing charts. Their responses were tabulated on a six point scale ranging from *Very Little* (1) to *Very Much* (6). These scales were intended to assess the receptivity of the pilots to IAP changes before they were exposed to any of the prototype chart concepts. Tables 5 and 6 present, respectively, the results for *content* and *format*.

Table 4. FMS Experience by Chart Flown

Chart Flown	FMS Experienced: Yes	FMS Experienced: No	Total
Volpe/ATA	32* 86.5%**	5 13.5%	37 100.0%
Jeppesen	25 56.8%	19 43.2%	44 100.0%
None	6 60.0%	4 40.0%	10 100.0%
Total	63 69.2%	28 30.8%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 8.48 with 1 d.f., p < .01)

Table 5. Impression of Improvement Possible in *Content* by Chart Flown

Chart Flown	Impression of Improvement Possible: Very Little	2	3	4	5	Very Much	Total
Volpe/ATA	4* 10.8%**	10 27.0%	9 24.3%	9 24.3%	4 10.8%	1 2.7%	37 100.0%
Jeppesen	1 2.3%	13 29.5%	13 29.5%	9 20.5%	5 11.4%	3 6.8%	44 100.0%
None		5 50.0%	3 30.0%	2 20.0%			10 100.0%
Total	5 5.5%	28 30.8%	25 27.5%	20 22.0%	9 9.9%	4 4.4%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 3.45 with 5 d.f., n.s.)

An interesting pattern emerges from an examination of Tables 5 and 6. It is clear that most of the participants were relatively negative or equivocal concerning the benefits

Table 6. Impression of Improvement Possible in *Format* by Chart Flown

Chart Flown	Impression of Improvement Possible						Total
	Very Little	2	3	4	5	Very Much	
Volpe/ATA	5* 13.5%**	4 10.8%	10 27.0%	13 35.1%	5 13.5%		37 100.0%
Jeppesen	1 2.3%	12 27.3%	10 22.7%	11 25.0%	6 13.6%	4 9.1%	44 100.0%
None	1 10.0%	3 30.0%		5 50.0%		1 10.0%	10 100.0%
Total	7 7.7%	19 20.9%	20 22.0%	29 31.9%	11 12.1%	5 5.5%	91 100.0%

*Entry is number of pilots (χ^2 = 20.40 with 5 d.f., n.s.)
**Percent is of chart flown

of possible chart changes. Almost 64 percent of the respondents were negative (scale values 1-3) relative to possible improvements from content changes. Over 50 percent were negative with respect to possible benefits from new formats. Of the remaining respondents who were positive, the majority were just slightly so (scale value of 4). These findings are consistent with the comments received. The typical comment was that they had been flying with the current standard chart for years and, although there was probably room for improvement, they really did not have major problems with it. The strong implication is that the two prototypes were facing an evaluative audience which saw little, if any, need for chart changes.

The resistance to changing the existing charts suggested in Tables 5 and 6 can be seen even more strongly in Table 7 which shows the content improvement impression tabulated by the format improvement impression. Almost 42 percent of the respondents were negative (scale values 1-3) on ***both*** the potential benefits from content and format changes to the existing charts. An additional 22 percent were negative concerning content changes and positive with respect to format changes. Only about 9 percent were positive about the potential for content changes but negative concerning format updates. Just over 27 percent were positive with respect to both attributes. It can also be seen from Table 7 that the content and format responses appear to be related suggesting that the pilots tended to be positive or negative on both dimensions (a Chi-square value was not calculated due to the number of sparse cells in the table). Altogether, a justifiable inference is that this group of pilots did not have the expectation, at the start of the data collection, that there was much benefit possible from improving the current approach charts.

Table 7. Impression of Improvement Possible in *Content* by Improvement Possible in *Format*

Impression of Improvement Possible in *Format*	Impression of Improvement Possible in *Content*						Total
	Very Little	2	3	4	5	Very Much	
Very Little	4 4.4%	2 2.2%	1 1.1%				7 7.7%
2		11 12.1%	5 5.5%	1 1.1%	2 2.2%		19 20.9%
3	1 1.1%	7 7.7%	7 7.7%	4 4.4%	1 1.1%		20 22.0%
4		6 6.6%	12 13.2%	9 9.9%	1 1.1%	1 1.1%	29 31.9%
5		1 1.1%		5 5.5%	5 5.5%		11 12.1%
Very Much		1 1.1%		1 1.1%		3 3.3%	5 5.5%
Total	5 5.5%	28 30.8%	25 27.5%	20 22.0%	9 9.9%	4 4.4%	91 100.0%

*Entry is number of pilots
**Percent is of total pilots

In addition to the attributes covered in the tables above, the pilots in the study were also asked if they were ATP qualified, the extent to which they used Jeppesen charts and if they had flown single-pilot IFR in the six months before the data collection. Only two of the 91 pilots were not ATP qualified. Fully 92 percent flew exclusively with Jeppesen charts, even when not flying in air carrier operations. Just 10 of the respondents (11 percent) had flown single-pilot IFR operations within six months of the data collection. It should also be noted that many of the participants volunteered the additional information that they were instructors or check airmen for their airlines. This placed them in a position to provide insightful comments on how various chart features would impact training or be handled by pilots with less experience than was characteristic of the respondents in this study.

In summary, the pilots who participated were an experienced group both in terms of flight hours and range of aircraft types flown. Their comments on the various chart features and their choices in the decision-to-buy exercise can therefore be considered representative of the responses of air carrier pilots in general.

3.2 DIRECT SCALING/DECISION-TO-BUY RESULTS

The primary objective of the present study was to explore the reaction of pilots to the various proposed IAP chart features. A comparison among the three chart types used in the study (current standard, Volpe/ATA prototype and Jeppesen prototype) was not a specific goal. A decision-to-buy exercise was included with the direct scaling data collection to encourage discussion among the members of each crew of their likes and dislikes for chart features. The results from the decision-to-buy, however, revealed significant preferences which were important in the interpretation of the findings with respect to individual features and in the derivation of recommendations.

Near the conclusion of the direct scaling session, each pilot was asked for his or her individual decision-to-buy choice of a chart to be used company-wide. Table 8 presents the results of that choice. The decision-to-buy results are presented in Table 8 as a function of "chart flown" because this was the only one of the available grouping variables which showed a meaningful pattern of differences. Other variables such as airline, flight hours and FMS experience were also examined, but none showed meaningful associations with decision-to-buy results. Two noteworthy results are clearly visible in Table 8. First, only one pilot selected the current standard chart. All 90 remaining participants selected one of the prototypes regardless of whether or not they had the opportunity to try one of them in the simulator. This is an extraordinary result given the pre-exposure resistance to change expressed by the pilots (Tables 5 and 6).

Table 8. ***Individual*** **Chart Choice by Chart Flown**

Chart Flown	Individual Chart Choice			Total
	Volpe/ATA	Jeppesen	Standard	
Volpe/ATA	31* 83.8%**	6 16.2%		37 100.0%
Jeppesen	18 40.9%	25 56.8%	1 2.3%	44 100.0%
None	5 50.0%	5 50.0%		10 100.0%
Total	54 59.3%	36 39.6%	1 1.1%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

($\chi^2 = 15.61$ with 2 d.f., $p < .001$)

Second, the pilots were significantly more likely to select the chart they had flown with (and been briefed on first) than they were to choose the chart they were briefed on second (and did not fly with). Overall, 56 of the 81 pilots (69%) who had the chance to use

one of the prototypes in a simulator chose that prototype. The 10 pilots who never flew either prototype split evenly in their choice.

A third finding concerning "chart choice" can be seen in Table 9 which presents the preferences of the 80 pilots who had flown with one of the prototypes ***and*** chose one of the prototypes in the Decision-to-Buy exercise. The table shows that the pilots who flew with the Volpe/ATA prototype chose it more frequently (83.8%) than the pilots who flew the Jeppesen prototype chose that prototype (58.1%). The corollary of this finding is that pilots who flew with the Jeppesen prototype chose the Volpe/ATA significantly more often (41.9%) than pilots who flew the Volpe/ATA prototype chose the Jeppesen (16.2%). Finally, it should be noted that among the 80 pilots who flew with either prototype, the Volpe/ATA prototype was selected by 49 (61.3%).

Table 9. *Individual* Chart Preference by Chart Flown

Chart Flown	Individual Chart Preference		Total
	Preferred Chart Flown	Preferred Chart *Not* Flown	
Volpe/ATA	31* 83.8%**	6 16.2%	37 100.0%
Jeppesen	25 58.1%	18 41.9%	43 100.0%
Total	56 70.0%	24 30.0%	80 100.0%

*Entry is number of crews
**Percent is of chart flown

(χ^2 = 6.23 with 1 d.f., $p < .05$)

After the individual chart choice exercise was completed, the participants in each session were asked to make a joint decision on which chart they would select for company-wide use. The results are shown in Table 10. They follow the same pattern as for the individual choice in Table 8. In this case, no crew chose the current standard chart. The one pilot who had selected the current standard as an individual choice was convinced by the other crew member to accede to a choice of a prototype. Among the 37 crews who flew, there was a notable tendency to select the Volpe/ATA prototype. The crews who did not fly either prototype were evenly divided between the two prototypes.

The individual and crew selections clearly show that the pilots overwhelmingly favored the prototypes to the current standard chart in spite of not expressing an a priori desire for IAP chart changes. There was a clear preference for the Volpe/ATA, although the Jeppesen prototype had a strong group of supporters. The results of the direct scaling shed some light on the derivation of the preferences observed. In this exercise, the pilots scaled

Table 10. ***Crew*** **Chart Choice by Chart Flown**

Chart Flown	Crew Chart Choice			Total
	Volpe/ATA	Jeppesen	Standard	
Volpe/ATA	15* 88.2%**	2 11.8%		17 100.0%
Jeppesen	8 40.0%	12 60.0%		20 100.0%
None	2 50.0%	2 50.0%		4 100.0%
Total	25 61.0%	16 39.0%		41 100.0%

*Entry is number of crews
**Percent is of chart flown

($\chi^2 = 9.09$ with 1 d.f., $p < .01$)

the three chart types on a 100 point scale for the functions of briefing an approach, executing a normal approach and executing a missed approach. Table 11 shows the mean and standard deviation of the direct scaling scores given for these three flight functions and the three chart types by chart flown. All of the differences between the current standard chart and either of the prototypes for the groups of pilots who flew either prototype are significant ($p < .001$) when tested by a paired t-test with 90 degrees of freedom. In addition, pilots who flew with the Volpe/ATA prototype scaled it significantly higher than the Jeppesen prototype for briefing an approach and executing either a normal or missed approach. Pilots who used the Jeppesen prototype in the simulator rated it significantly higher than the Volpe/ATA prototype for executing a normal approach. The entire group of pilots scaled the Volpe/ATA chart significantly higher for briefing an approach, which supports the briefing strip concept.

Table 12 shows which chart was scaled highest (received the highest scale score given by a particular respondent regardless of magnitude) for briefing an approach. There is a significant association between the chart flown and the one rated highest. There is also a clear preference for the Volpe/ATA prototype. Overall, 73.6 percent of the participating pilots rated the Volpe/ATA prototype highest for briefing an approach. Even 59.1 percent of those who flew with the Jeppesen prototype, and therefore did not have the opportunity to try the Volpe/ATA chart format, selected the Volpe/ATA for this function. The general comments and those on individual features (discussed below) further suggest that the use of the Briefing Strip on the Volpe/ATA prototype was extremely well received.

The chart scaled highest for executing a normal approach to touchdown and wheel stop is shown in Table 13. Once again, the strong influence of having the opportunity to fly a chart in the simulator is evident. The proportion of pilots who rated each prototype

Table 11. Mean and Standard Deviation of Direct Scaling Values by Chart Type

Flight Function / Chart Flown	Chart Type: Volpe/ATA	Jeppesen	Standard
Briefing an Approach			
Volpe/ATA (N=37)	87.8* 12.6**	54.1 17.7	36.1 16.5
Jeppesen (N=44)	70.2 25.7	69.4 19.2	44.9 17.0
None (N=10)	70.8 29.8	69.0 11.0	53.0 12.5
TOTAL (N=91)	77.4 23.3	63.2 19.2	42.2 17.2
Executing a Normal Approach			
Volpe/ATA	81.6 16.0	66.6 14.0	41.7 14.5
Jeppesen	66.1 18.5	77.5 20.3	50.5 15.6
None	66.0 22.7	81.0 11.0	50.5 9.0
TOTAL	72.4 19.4	73.4 17.9	47.0 15.1
Executing a Missed Approach			
Volpe/ATA	85.4 15.9	65.3 17.1	40.5 16.7
Jeppesen	69.7 26.0	73.5 16.8	47.8 19.8
None	76.0 27.9	80.0 7.1	51.5 12.0
TOTAL	76.8 23.6	70.9 16.8	45.3 18.2

*Entry is *mean* direct scaling value on 0-100 scale
**Entry is *standard deviation* of scaling value

Note: Shaded cells indicate significant differences ($p < 0.05$) between the Volpe/ATA and Jeppesen prototypes based on a paired t-test. All differences between the Standard and both prototypes are significant ($p < 0.05$) for all tests involving pilots who flew with either prototype.

Table 12. Chart Scaled Highest for *Briefing an Approach* by Chart Flown

Chart Flown	Chart Scaled Highest			Total
	Volpe/ATA	Jeppesen	Standard	
Volpe/ATA	34* 91.9%**	3 8.1%		37 100.0%
Jeppesen	26 59.1%	18 40.9%		44 100.0%
None	7 70.0%	3 30.0%		10 100.0%
Total	67 73.6%	24 26.4%		91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 11.26 with 1 d.f., $p < .001$)

Table 13. Chart Scaled Highest for *Executing an Approach* by Chart Flown

Chart Flown	Chart Scaled Highest			Total
	Volpe/ATA	Jeppesen	Standard	
Volpe/ATA	28* 75.7%**	9 24.3%		37 100.0%
Jeppesen	11 25.0%	32 72.7%	1 2.3%	44 100.0%
None	3 30.0%	7 70.0%		10 100.0%
Total	42 46.2%	48 52.7%	1 1.1%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 19.98 with 1 d.f., $p < .001$)

highest for executing an approach is approximately equal for the 81 pilots who actually flew (75.7% who flew the Volpe/ATA rated it highest; 72.7% who flew the Jeppesen rated it highest). Seven of the 10 pilots who did not fly a prototype rated the Jeppesen prototype highest, and only one pilot (who flew the Jeppesen prototype) rated the current standard

highest. Clearly, the prototypes were preferred over the current standard for executing a normal approach. There was a slight overall tendency to rate the Jeppesen prototype highest for this function (52.7% to 46.2%). The current standard chart was only rated highest for executing a normal approach by one pilot even though there is great similarity among the Plan View, Profile and Minimums sections of all three chart types with respect to normal approach information. The difference in means from Table 11 (72.4 for the Volpe/ATA versus 73.4 for the Jeppesen) is not significant (t = 0.75 with 90 d.f., n.s.).

The results for executing a missed approach, as shown in Table 14, support the Volpe/ATA prototype with its iconic representation of the initial "up and out" flight maneuvers. The 10 pilots who did not fly with a prototype were equivocal, and one pilot selected the current standard chart. Of the remaining 80 pilots, 60 (75.0%) selected the Volpe/ATA prototype for this function. Over 60 percent of the pilots who flew with the Jeppesen prototype still selected the Volpe/ATA prototype for executing a missed approach. The difference in mean scale scores between the Volpe/ATA and Jeppesen prototypes as shown in Table 11 (76.8 versus 70.9) just failed to make the 0.05 level of statistical significance (t = 1.85 with 90 d.f., n.s.).

Table 14. Chart Scaled Highest for *Executing a Missed Approach* by Chart Flown

Chart Flown	Chart Scaled Highest			Total
	Volpe/ATA	Jeppesen	Standard	
Volpe/ATA	32* 86.5%**	5 13.5%		37 100.0%
Jeppesen	28 63.6%	15 34.1%	1 2.3%	44 100.0%
None	5 50.0%	5 50.0%		10 100.0%
Total	65 71.4%	25 27.5%	1 1.1%	91 100.0%

*Entry is number of pilots
**Percent is of chart flown

(χ^2 = 4.84 with 1 d.f., p < .05)

The direct scaling and decision-to-buy data present a strong picture of a major change in attitudes among the pilot participants after their exposure to the prototypes. Prior to seeing a prototype, there was little enthusiasm for changes in content or format of current standard IAP charts. After a briefing on either of the prototypes and, particularly after a simulator session with one of them, all of the pilots except one showed a clear preference for the prototypes over the current chart version. There was also clear sentiment in favor

of the Volpe/ATA for briefing an approach and executing a missed approach. This pattern of preferences is consistent with the comments on individual chart features reported below.

3.3 INDIVIDUAL CHART FEATURES

The bulk of the debriefing time with the pilots was spent on discussing the individual features of each prototype. First, a rating on a six point scale was obtained from each crew member for each feature. Then, the reasons for the scaled responses were discussed in detail. This section presents the results of all of the debriefings, for both flown and not flown prototypes, on specific features. In both cases, the debriefing was the same, the crews were asked to compare the unique features of each prototype to the equivalent features on the standard chart. As shown in the Protocol, the crews were asked to judge if the feature made the prototype better or worse than the standard. There were, in addition, two questions requiring a "yes or no" response relative to the circle-to-land minimums as shown on the Volpe/ATA chart.

This section is organized into four major parts: Heading, Plan View, Profile View, and Minimums, which correspond to the major parts of the current standard chart as well as the two prototype charts. Within each major part, the results related to each prototype are presented separately. A copy of each standard and prototype chart reviewed in this study is contained in Appendix B for the reader who may wish to refer to the charts and features as they are discussed.

The focus in this section is on the qualitative results obtained. These were derived in large part from an analysis of the video record made of the discussion that took place in each debriefing. The research team reviewed each video tape and recorded each relevant comment. These comments were later collated to avoid repeating ideas that were expressed by more than one person. No attempt was made to determine the frequency of these comments, because there was no requirement for the crews to comment. The comments reported here were ones volunteered by the crews. The fact that a crew did not comment on a given topic in addition to their rating does not mean they held a contrary opinion or had no opinion: there was simply no comment. The observations of the research team made during the simulated approaches as well as the comments made by the crews in the simulators have also been included here. Where appropriate, reference is made to the quantitative data from analysis of the scaled responses which are contained in appendices.

Appendices C and D cover, respectively, results for the Volpe/ATA and Jeppesen prototypes. Each Appendix is divided into two parts. Part 1 contains analyses of the scaled responses (and "yes/no" responses for the Volpe/ATA prototype). The scaled data are presented in several ways. First, a cross-tabulation of the actual scale values is presented as a function of which chart was flown. Then, mean and standard deviations are presented for each subgroup (those who flew with the Volpe/ATA prototype, those who flew with the Jeppesen prototype, and those who did not fly) and for all the 91 subject pilots. Three separate means and standard deviations are shown. These are the raw (untransformed) value, a traditional Z-score and the range transformation described previously in Section 2.

Part 2 of Appendices C and D is a compendium of the comments made by the crew members during the debriefing process. The crew comments are organized so that similar comments are grouped together and may have been paraphrased for brevity and to ensure understanding. Similar comments for each chart feature are reported only once.

Appendix E contains a compilation of crew and/or pilot observer comments made during the simulator sessions pertaining to all three types of chart flown. These comments were also organized so that similar comments were grouped together and may have been paraphrased to ensure understanding.

3.3.1 Heading Features: Volpe/ATA Prototype Chart

The Heading area of the Volpe/ATA prototype was completely redesigned into a Briefing Strip. In addition to the new formatting, the Briefing Strip contained a repetition of information found in the other parts of the chart and the addition of the light diagram for the intended runway.

3.3.1.1 Briefing Strip Concept - The Briefing Strip concept was well received as indicated by the comments and positive responses on several of the scales by the pilots. The gist of the comments was that the addition of the Briefing Strip is a desirable, very useful feature. It brings together the essential elements of information for an approach briefing and organizes it in a logical order to facilitate the conduct of the briefing. With regard to the need for the Briefing Strip information to support programming a flight management computer, the pilots commented that this information is preprogrammed in the FMS data base for most aircraft and, therefore, programming in flight is not typically required.

Three of the scaled response questions made direct reference to the Briefing Strip. Question 1 addressed the first row of the Briefing Strip which contained quick reference information used in briefing an approach or in executing last minute changes. Question 4 dealt with the consolidation of notes, approach lighting, missed approach text, and airport elevation in the third row of the Briefing Strip. For both questions, the response of those pilots who actually flew with the Volpe/ATA prototype was notably positive. The mean raw scores in excess of five and mean Z-scores greater than one standard deviation are among the highest obtained in the study. The balance of the pilots who either flew with the Jeppesen prototype or did not fly were equivocal on these scales.

Question 3 asked about the communication information in the second row of the Briefing Strip. The entire pilot population in the study was equivocal about this feature. Comments suggested that it was reasonable to include communication information, but the frequencies themselves were not part of the briefing. Therefore, placing them in the middle of the Briefing Strip interrupted the flow of the briefing.

3.3.1.2 Touchdown Zone Elevation (TDZE) - For non-precision approaches to either of two runways, showing both TDZEs on the Briefing Strip (see Volpe/ATA Prototype Chart, Los Angeles VOR Rwy 25L/R in Appendix B) was rated as somewhat negative by all of the pilot groups (Question 2). Most of the pilots felt that including both TDZEs to a pair of runways

in the Briefing Strip is not a big benefit. They commented that this information is adequately shown in the Profile View near the end of the approach on the current standard chart. It must be noted that the comments on this feature suggested that the respondents were not opposed to inclusion of TDZE information in the Briefing Strip. They simply did not see it as an improvement over the current chart even though the Briefing Strip itself was well received.

3.3.1.3 Horizontal Alignment of the Communication Frequencies - In addition to the inclusion of the communication frequencies in the Briefing Strip, their format was also addressed in Question 3. There was no clear frequencies preference expressed. Some pilots commented that the horizontal format seems better and is easier to read. Others preferred the current vertical layout. The general impression of the research team was that any coherent format which permits a pilot to access the communication information quickly and unambiguously when needed would be acceptable.

3.3.1.4 Consolidation of Notes, Approach Lighting, Missed Approach Text and Airport Elevation - Pilots who flew the Volpe/ATA prototype rated the consolidation of notes, the addition of the approach lighting information, the inclusion of the missed approach text and airport elevation in the Briefing Strip positively. Pilots who did not fly the prototype also rated these features positively, although the scores were somewhat lower than for those pilots who flew the Volpe/ATA chart. Uniformly positive comments were received regarding the addition of the approach lighting diagram on the charts. Suggestions were also made to indicate the type of lighting system, e.g., VASI, PAPI, REILS, etc., on the chart. Identifying the type of lighting system on the chart will reinforce or assure the pilots on breakout that they are landing on the correct runway.

The consolidation of notes in a "notes box" in a dedicated area was viewed as an improvement. In general, however, there was agreement that not all types of notes should be consolidated in one area on the chart. The prototype chart combined procedural, equipment, navigation and altitude related notes in a notes box on the third line of the Briefing Strip. It was suggested that navigation and altitude related notes should be placed in the Profile View which is the chart area a pilot is referencing when this information is needed. It was suggested that all other notes, e.g., procedural, equipment, should be consolidated in the notes box of the Briefing Strip since they should be part of the pre-approach briefing.

Comments also suggested that including the missed approach text in the Briefing Strip was an improvement since this information is an essential part of the briefing. The entire text might also be needed in the rare situation in which a missed approach was carried all the way to the published hold point. Otherwise, the iconic representation of the initial "up and out" procedures of the go around in the Profile area of the chart should be sufficient.

No comments were received with respect to the specific *placement* of the airport elevation in the third row of the Briefing Strip. This information is in the heading of the current standard chart. The few comments received suggested that the pilots wanted this information to remain somewhere in the chart Heading.

3.3.2 Heading Features: Jeppesen Prototype Chart

The Heading area of the Jeppesen prototype was not radically different from the Heading area of the current standard chart. Nevertheless, there were some distinctive changes which were covered by several scaled questions in the debriefing.

3.3.2.1 Approach Briefing Data - The first question relative to the Jeppesen prototype dealt with the reformatting of data in the header area of the chart. Overall, the pilots were neutral to this as an improvement relative to the current standard chart. Pilots who flew with the Jeppesen prototype rated this feature slightly higher than those who flew with the Volpe/ATA prototype. Several pilots commented that there does not appear to be much of a change in this area on the Jeppesen prototype. For those respondents who saw the Jeppesen prototype last, the comment was made that the Briefing Strip on the Volpe/ATA chart is more complete for briefing an approach.

3.3.2.2 ICAO Identifier - The four letter International Civil Aviation Organization (ICAO) identifier was added to the Jeppesen Prototype in the header area. When using the current standard chart or the Volpe/ATA prototype, a crew member would have to obtain the ICAO identifier from the separate Airport Chart. Question 2 covered the addition of the ICAO identifier. Its inclusion was rated equivocally by all groups. The overall feeling was that, for domestic operations, this was not a significant feature; however, for international operations it was considered a desirable feature. It was also mentioned that the ICAO identifier is more important for FMS-equipped aircraft because the identifier is the key to airport entry. However, even in this case, it is not vital to have it on the chart since it will always be on the airline-produced flight plan.

3.3.2.3 Frequency and Call Sign of the Primary Navaid - The comments of the pilots indicated that the use of large, boldfaced type for the primary navigation aid (navaid) was an improvement from the current standard chart. The positive comments stemmed primarily from the fact that the large boldface type is easier to read. However, most of the pilots indicated that they obtain this information from the "racetrack" oval on the Plan View of the chart rather than from the Heading area. It is interesting to note that the scaled responses to Question 3 were not as positive as the subjective comments would have predicted. It is believed that the comments are a more accurate indicator of preference and that the more subdued response to the scale question is merely indicative of the fact that this is not considered a crucial feature by pilots.

3.3.2.4 Chart Index Number - The pilots rated the bolding of the chart index number on the Jeppesen prototype uniformly negative whether or not they flew the prototype chart. Pilots commented that the information is in a fixed location on each chart and is not usually used during periods of stress or high workload. The primary uses of the chart number are to confirm that all crew members have accessed the same chart and for filing the chart. Therefore, bolding is not necessary and its use might detract from other uses of boldface on the chart.

3.3.2.5 Arrangement of Communication Information - The vertical formatting arrangement in order of use and placement of a box around the communications information was scaled uniformly positive (Question 5) by the respondents. Those pilots who flew the Jeppesen prototype and those who did not fly either prototype were somewhat more positive than those who flew the Volpe/ATA prototype. Positive comments included that the revised format of the communication information is more organized, more pleasing, and easier to read than the standard chart.

3.3.2.6 Use of Bold for Communication Frequencies - Pilots who flew the Jeppesen prototype chart scaled the bolding of the communication frequencies more positively than those pilots who flew with the Volpe/ATA prototype or did not fly a prototype (Question 6). The comments tended to indicate that those who had the chance to use the chart found the frequency information easier to read. Absent this experience, the pilots were concerned that bolding items such as communications frequencies which are not used often or under pressure might dilute the benefits of bolding elsewhere on the chart.

3.3.2.7 Minimum Safe Altitude (MSA) Origin Point and Identification - The Minimum Safe Altitude (MSA) Circle on the Jeppesen prototype, as on the current standard chart, is fixed in position in the header area. On the prototype, however, the MSA origin is shown by the navaid symbol in the center of the circle. The characters identifying the navaid remain outside the MSA as on the current standard chart. Showing the MSA origin point as a symbol in the MSA circle was rated mildly positive by the pilots who flew the Jeppesen prototype chart and mildly negative by the pilots who flew the Volpe/ATA prototype (Question 8). Overall, the pilot response was largely neutral. Both groups of pilots expressed the need to have the MSA point of origin and identification information contained on the chart. They did not, however, have strong feelings about where this information was placed relative to the circle since it is not a quick reference item.

3.3.2.8 MSA Sector Depicted as Radials - Question 9 addressed the use of radials (rather than bearings) to define the sectors of the MSA. This same approach was used in the Volpe/ATA prototype. Comments indicated that the vast majority of study pilots preferred the radials because they are easier to understand and minimize any conversion requirement. They tend to think about all of their navigation chores in terms of radials and did not want to have to convert to bearings for only the MSA sector definitions.

3.3.3 Plan View Features: Volpe/ATA Prototype Chart

The Plan View of the Volpe/ATA prototype was not a radical departure from the current standard chart. There were, however, several modifications which were assessed during the debriefings. The MSA on the Volpe/ATA prototype was placed in the Plan View but allowed to "float" into available free space. The location of the MSA was not the subject of a specific question. Comments indicated that the variable placement would not present any operational problems because the circle itself is large and easy to locate even with a quick scan.

3.3.3.1 Identification of the Referenced Navaid for the MSA by Its Call Sign - The referenced navaid for the MSA on the Volpe/ATA prototype was indicated by its call sign in the center of the circle. Question 5 of the Volpe/ATA prototype debriefing addressed this feature. Compared to the current standard chart, pilots who flew the Volpe/ATA prototype rated this feature mildly positively. On the other hand, pilots who flew the Jeppesen prototype rated the feature mildly negatively. Although the pilots generally liked the placement of the MSA in the Plan View, they indicated MSA was greatly improved if it included ***both*** the applicable navaid symbol, as on the Jeppesen prototype, ***and*** the character identification. This removed any ambiguity concerning the MSA reference.

3.3.3.2 Radials Rather than Bearings to Define Sectors of the MSA - The results for this feature (Question 6) paralleled those for the similar question related to the Jeppesen prototype. Regardless of which prototype was flown, the respondents were uniformly positive about the replacement of bearings with radials in the MSA. The reasons given in the comments were the same as those presented during the Jeppesen prototype debriefings.

3.3.3.3 Sectional Chart Notation for the Altitudes in the MSA - The use of Sectional Chart notation (large, bold numerals for thousands of feet and a smaller numeral for hundreds with the trailing zeroes removed, e.g., **2**6 for 2,600 feet) on the Volpe/ATA prototype was assessed by Question 7. The response was uniformly negative, with those who flew the Volpe/ATA prototype being even more negative than those who did not. Although they commented that they could get used to Sectional Chart notation in the MSA, pilots much preferred depicting the full number as shown on the current standard chart and the Jeppesen prototype. Their main concern was the possibility of ambiguity, particularly for minimum safe altitudes greater than 10,000 feet.

3.3.3.4 Box Around the Approach Course - The use of a box around the approach course on the Volpe/ATA prototype chart was rated positively by those pilots who flew the chart and by those who did not fly at all (Question 8). The pilots who flew the Jeppesen prototype, however, were somewhat negative in their rating. This can be traced directly to the fact that those who flew with the Jeppesen prototype preferred the use of bolding rather than a box to emphasize the approach course (see below). Comments also included that the approach course heading is often obtained from the primary navaid data within the "racetrack."

3.3.3.5 Obstacles and Airports within Five Miles of the Approach Course - The depiction of only those obstacles and airports within 5 miles of the approach course was negatively scaled regardless of prototype flown (Question 9), although there was considerable variation of opinion on this subject. There was also much discussion regarding the depiction of this information. Comments included that all airports, particularly any that could support air carrier operations, should be depicted on the chart's Plan View. All significant obstacles, in particular those depicted as the highest obstacles, should also be shown on the chart's Plan View. Sentiment was expressed for retaining the black arrow pointing to the highest obstacles as is done in the current standard chart. The pilots appreciated the decluttering accomplished by the obstacle depiction criteria used in the Volpe/ATA and Jeppesen prototypes. Their feeling was, however, that it went too far and removed information they

considered vital for situational awareness and emergency operations, e.g., engine-out go-arounds.

3.3.3.6 Controlling Obstacle - Question 10 addressed the inclusion of the controlling obstacle on the Volpe/ATA prototype even if it is outside of the five mile criterion. The controlling obstacle is part of the U.S. Standard for Terminal Instrument Approach Procedures (TERPS) criteria and has not been a part of the current standard chart. The scale scores for this question were uniformly negative. Discussions indicated that the concept of a controlling obstacle was not well known to the pilots in the study. As a result, there was a general pilot consensus that this information was not a useful chart feature.

3.3.3.7 Middle Marker Information - The Volpe/ATA prototype design deletes the middle marker information from the Plan View. As assessed by Question 11, this deletion was negatively received by those who did and did not fly the prototype. The pilots commented that the depiction of the middle marker on the Plan View should remain to be consistent with this information in the Profile View. The redundancy of information was not viewed as adding significantly to chart clutter.

3.3.3.8 Deletion of Primary Navaid Morse Code - The Morse Code for the primary navaid was deleted from the "racetrack" oval in the Plan View of the Volpe/ATA prototype because the information is redundant with that contained in the Briefing Strip. This deletion was rated negatively by all groups of pilots (Question 12). Those who flew the Volpe/ATA prototype were less negative than those who flew the Jeppesen prototype or did not fly at all. The stated rationale was that pilots normally look for this primary navaid-associated information in the Plan View, and that showing it is consistent with the display of the Morse Code for other navaids depicted in the Plan View of the chart.

3.3.4 <u>Plan View Features: Jeppesen Prototype Chart</u>

3.3.4.1 Bold and Aligned Approach Fixes - The approach fixes in the Plan View of the Jeppesen prototype were bolded and aligned on one side of the approach course. This was a departure from the method used in the current standard chart and the Volpe/ATA prototype. Question 7 of the Jeppesen prototype debriefing addressed the pilots' reaction to this change. The response was uniformly positive with those who flew the Jeppesen prototype reacting with particular zeal. Most of the pilots agreed that the placement of all the approach fixes in bold on one side of the approach course was a definite improvement because it facilitated easy access and readability.

3.3.4.2 Obstacle Information - The Jeppesen prototype also attempted to declutter its Plan View by removing obstacles. The criterion used was to remove all obstacles and airports which are more than one mile from the approach course. As with the similar question for the Volpe/ATA prototype, Question 10 for the Jeppesen prototype dealing with the removal of obstacles provoked a decidedly negative response. Although those who flew with the Jeppesen prototype were less negative than the balance of the sample, it was clear that few favored this radical a retreat from the current information level. Pilot comments centered around their desire to know where the highest obstacle was on the plate. They also wanted

to retain the location and information of nearby airports on the chart for situational awareness, e.g., pop-up traffic.

3.3.4.3 Final Approach Course Depicted in Large Type - The depiction of the final approach course on the Jeppesen prototype in large type received a slightly positive response overall (Question 11). Those who actually had the opportunity to use the Jeppesen prototype, however, were considerably more positive, and those who flew the Volpe/ATA prototype rated more towards the neutral. The typical comment from those who liked the change was that the large type made the course information on the prototype easier to read and quicker to locate. The balance of the comments suggested that, although the large type was appreciated, improving the readability of this feature was not a major upgrade to IAP charts.

3.3.4.4 Procedural and Equipment Notes in a Notes Box - Notes dealing with aircraft equipment or general approach procedures were placed in a notes box which was allowed to "float" to available space in the Plan View of the Jeppesen prototype. Question 12 assessed reaction to this approach. Overall, the respondents were quite positive about this feature. The universally positive response seen is consistent with the comments for both prototype charts that having the notes in one location is better than having them scattered all over the chart. Several pilots mentioned knowing of pilots who had received violations for missing a note that was embedded in an inconspicuous place on a chart.

3.3.4.5 Missed Approach Fix - Both prototypes retain the map or Plan View of the missed approach procedure as part of the Plan View section. The Jeppesen prototype, however, uses large, boldfaced type for the name of the missed approach fix. This usage was assessed by Question 14. It received a generally positive response from those who flew the Jeppesen prototype as well as from those who flew the Volpe/ATA prototype and those who did not fly. Pilots commented that the bolding of the fix name is much better because it is more readable under the stress of executing a go-around.

3.3.4.6 Airport Highlighted with a Shaded Circle - The highlighting of the airport with a shaded circle on the map view of the chart was uniformly rated very negatively (Question 16). This feature received perhaps the most negative response in the study. It was clear from the comments that the shading circle was not seen as a useful chart feature.

3.3.5 Profile View Features: Volpe/ATA Prototype Chart

3.3.5.1 "Up and Out" Missed Approach Maneuvers Depicted by Icons - The depiction of the "up and out" missed approach maneuvers by icons was rated extremely positively by pilots who flew the Volpe/ATA prototype (Question 13). Pilots who flew the Jeppesen prototype were also positive, but only slightly so. Those who did not have the opportunity to fly either chart were more in favor of the feature than those who flew the Jeppesen prototype, but less enthusiastic than those who flew the Volpe/ATA prototype. The comments suggested that those who did not have the chance to use the icons were somewhat concerned about their ability to grasp the meaning of the "little pictures," while those who used them found them largely intuitive. Discussion focused on the number of icons to be presented and the format of the information within them. There was general agreement that the number of icons

should be restricted to just what was needed to get the aircraft safely up and away from the runway (perhaps two minutes from the Missed Approach Point). It was felt that it would become too difficult to interpret more than that. There was also a clear preference for bolding both the frequency and radial information presented within any icon.

3.3.5.2 Touchdown Zone Elevation (TDZE) in Bold - The use of bold type for the TDZE of the intended runway was rated positively by pilots who flew the Volpe/ATA prototype chart (Question 14). This feature was, however, rated lower by pilots who flew the Jeppesen prototype and by those who did not fly either prototype. The comments indicated that those who had flown the Volpe/ATA prototype appreciated the bolding of the intended runway even though it is not "high priority" information. Those who did not fly it suggested that it might not be sufficiently important to warrant the emphasis.

3.3.6 Profile View Features: Jeppesen Prototype Chart

3.3.6.1 Bolding of the Navigation Elements of the Missed Approach Procedure - The missed approach procedure text on the Jeppesen prototype is located as it was on the current standard chart in the Profile area. The Jeppesen prototype, however, uses bold type for those words in the missed approach text which are actual navigation elements such as altitudes, headings and holding fixes. This bolding of the navigation elements of the missed approach procedure was very well received by all groups of pilots because it adds emphasis and improves readability (Question 13).

3.3.6.2 "M" to Indicate Missed Approach Point - Although not a specific question on the protocol and therefore not a rated feature, pilots commented that the letter "M" to indicate the missed approach point in the Profile View is not a meaningful feature on either the current standard chart or the Jeppesen prototype since the missed approach point it is depicting is not fixed in space. They recommended that this feature be deleted from future chart revisions.

3.3.7 Minimums Section Features: Volpe/ATA Prototype Chart

3.3.7.1 Decision Altitudes for Straight-In Landings are Bolded - The Minimums section contains references to various altitudes at which pilots must make navigation decisions. These altitudes were depicted by bold type on the Volpe/ATA prototype. Question 15, assessing reaction to this feature, produced a uniformly positive reaction whether or not the respondent actually flew the Volpe/ATA prototype. In fact, the pilots who flew the Jeppesen prototype actually rated this feature more positively than the pilots who flew the Volpe/ATA chart. The major comment regarding this feature was that the bolding really emphasized this key information and made it more readable. It was again noted that failure to adhere to these altitudes can result in a safety violation. Therefore, anything which helped ensure that the crew was flying to the correct altitude targets was much appreciated.

3.3.7.2 Circle-to-Land Minimums on Charts - Questions 16 and 17 were "Yes/No" items added shortly after the data collection effort was underway. They dealt with the need to include circle-to-land minimums on charts for air carrier operations even though most of the

air transport carriers have company-specified minimums of a 1,000 foot ceiling and three miles visibility ("1,000 and 3"). Of the 65 pilots who were asked if circle-to-land minimums were needed, 40 (61.5%) responded "Yes." These pilots commented that circle-to-land minimums higher than "1,000 and 3" would have to be shown anyway. Therefore, for consistency, circle-to-land minimums should be shown on all applicable charts even if they are at or below the industry-standard "1,000 and 3". Those pilots who indicated that they saw a need for circle-to-land minimums were then asked if they preferred the format shown on the Volpe/ATA prototype to that used on the current standard chart. Thirty-seven of the 40 pilots (92.5%) responded affirmatively. An example of the preferred format is shown on the Volpe/ATA prototype charts for approaches to Chicago O'Hare ILS Rwy 14R and VOR Rwy 22R and Denver Stapleton ILS DME-1 Rwy 8R and NDB Rwy 26L in Appendix B.

3.3.8 Minimums Section Features: Jeppesen Prototype Chart

Question 15 was the only item which addressed Minimums Section features of the Jeppesen prototype. Showing minimum altitudes in bold (the same as in the Profile View) was rated very positively for the Jeppesen prototype. This is consistent with the finding reported earlier for the Volpe/ATA prototype. Pilot comments were also similar to those received for the Volpe/ATA prototype. The information was easier to find and read, and, therefore, the risk of a safety violation is reduced.

3.3.9 Other Comments: Both Prototypes

Three other chart features which were not specifically addressed by questions prompted a significant number of comments.

3.3.9.1 Deletion of Aircraft Approach Categories A and B in Minimums Area - The current standard chart includes landing minimums for four aircraft approach categories (A, B, C and D).* The Volpe/ATA prototype eliminated categories "A" and "B" as these are for aircraft maneuvering at less than 121 knots and therefore do not apply to air carrier operations. Although not the subject of a specific question, the deletion of these extraneous categories prompted numerous positive comments because of reduced clutter.

3.3.9.2 Ground Speed - Knots Chart - The Volpe/ATA prototype deleted all ground speeds below 120 knots in the reference table at the bottom of the chart. The rationale was that aircraft used in air carrier operations do not approach at these lower speeds and do not need the information. Removing them would declutter the chart. Several pilots pointed out, however, that there are some air carrier aircraft which have sufficiently slow approach speeds that they could be approaching below 120 knots *ground speed* if they encountered a significant headwind. They therefore recommended the inclusion of a column for 100 knots in the table.

---

*Aircraft Approach Categories are groupings of aircraft based on a speed of 1.3 times the stall speed in the landing configuration at maximum gross landing weight.

3.3.9.3 Visual Descent Point (VDP)/Planned Descent Point (PDP) - The discussions about the cross-reference table at the bottom of the chart led to the realization that there is another parameter pilots regularly use which is not included. This is the VDP for non-precision approaches and its functional equivalent (which might be called a Planned Descent Point) for precision approaches. To minimize in-flight calculations, it was suggested that future charts include, where appropriate, calculated VDP/PDP information for each ground speed shown in the table.

4. DISCUSSION AND RECOMMENDATIONS

4.1 DISCUSSION

The results presented in the previous section show a clear preference among the pilots in the study for changes in the current instrument approach charts. The data and comments as interpreted by the project staff led to recommendations for a redesigned IAP chart for air carrier use. Before presenting the recommendations which emerged from this study, it is of special interest to note two aspects of this work that are significant for the planning and conduct of other IAP chart research and, in fact, any research based on interaction with air carrier pilots. First, it is a commonly held view that airline pilots are resistant to change and prefer using tools and procedures with which they are fully familiar. This may be attributed to their overriding concern for safety so that rather than try a new device or procedure they would prefer to use one that, in their experience, has worked safely and successfully. It also may be considered an inherent, conservative trait of successful pilots. Whatever the rationale, the common wisdom is that pilots resist change.

In this study, the first information collected from each pilot was his or her estimate of the potential for improvement of the current standard IAP chart. They were asked to consider the content and the format of the chart separately. These ratings, as reported in Tables 5, 6 and 7, would tend to support the impression that pilots are resistant to change. However, when the pilots were guided systematically through all of the current Jeppesen features and asked to consider the potential for improvement feature-by-feature, they identified many which could be improved. They also volunteered numerous suggestions for modifying features and for additions to the chart (see Part 2 of Appendices C and D). Later, when the prototypes were introduced, there was significant acceptance of many of the new ideas expressed in the prototypes, and even more suggestions for new or revised features were elicited. A number of pilots indicated that they had altered their assessment of the potential benefits from change after exposure to the new chart ideas on the prototypes and their own deeper consideration of the current chart. What can reasonably be inferred from this is that pilots apparently were better able to consider and evaluate changes when dealing with actual examples rather than with the *concept* of change.

The second noteworthy finding of this study deals with the effect of actually using the prototypes for simulated approaches. The study results show that there was a strong, consistent association between the intensity of the pilots' opinion of chart features and which prototype was used in the simulator. Opinions regarding the features of the flown prototype were much more favorable than opinions of the second prototype, which was briefed but not flown. No other factor in the study by which pilots could be characterized, e.g., airline, type rating, was a meaningful predictor of pilot preference. It must therefore be concluded that the additional effort involved in securing and using simulator time for this and future studies of pilot reactions to in-flight human factors issues is well worthwhile. The research team is convinced that the opinions with respect to the acceptability of chart features, particularly those which represented the most radical departure from the current standard

chart, would have been less considered and certainly less positive if the pilots had not had the opportunity to fly with the prototypes.

4.2 NATURE OF THE RECOMMENDATIONS

The basic purpose of this study was to help improve the speed and accuracy with which air carrier pilots can acquire information from IAP charts. The primary research approach was to evaluate the potential for improvement offered by concepts illustrated in two prototype charts. This evaluation was performed essentially on a feature-by-feature basis using the current chart as reference. Thus, the results presented in this report focus on each of the several features contained in the two prototypes and in the current standard chart and identify preferences of the participating pilots for each feature.

The final research objective for this study, however, was to compile the evaluation results, including all pertinent and feasible suggestions, to provide a basis for either the revision of one of the prototypes or the specification of a new IAP chart. The evaluation results that have been compiled are of three types: preferred prototype features, features that were suggested by the participating pilots (in interaction with the research team), and aspects of the current standard chart that were explicitly preferred (or were not explicitly rejected by the pilots).

Even before this compilation was completed, it became evident that neither of the two prototypes would completely satisfy all of the preferred and requested improvements. This was not unexpected since each prototype was developed to illustrate new concepts and to stimulate the consideration of new approaches to IAP chart design. The study was not a competition between the prototypes, but a process of developing new and improved means for presenting IAP chart information. What did become evident early in the study was that some features of each prototype would be judged to be very useful and that a "final product" would have to accommodate these as well as new concepts developed in the course of the study.

The Volpe/ATA prototype included a Briefing Strip which was accepted by virtually all of the participating pilots, but with refinements to make it fully responsive to air carrier operations and procedures. This prototype also used icons to depict the "up and out" segment of a go-around, and these too were widely endorsed by the pilots. The Jeppesen prototype featured a substantial change in the organization of information on the chart, particularly in the Plan View with its depiction of all of the fixes for the approach aligned on one side of the approach course center line. These features were widely accepted as was Jeppesen's use of large and bold type to improve legibility and to emphasize important information. As the study progressed through the review and interpretation of results, the concept emerged of a new chart that would be an amalgam of features from both prototypes with new ideas generated by the study.

Most of the recommendations for features to be included in a new chart were derived directly from the study results. In some cases, however, the data were not definitive. For these features, the research team reviewed the data in light of their experience in the field

study and derived a workable and feasible specification for the feature(s) concerned. A working assumption in assembling this set of features was that if there had been no comment on, or suggested replacement for, a current Jeppesen feature, it would be retained in its current form.

4.3 DETAILED RECOMMENDATIONS

In this section, each of the features recommended for inclusion in an improved IAP chart is described. There is also a brief rationale for the inclusion of the feature as well as for its design. Figure 5 is a depiction of the recommended chart with the features described below. It has been prepared to facilitate the understanding of the descriptions. It is recommended that there be no change in paper weight or size if the new chart is produced, as these were never identified as problem sources and keeping them the same would facilitate the continued use of current binders, clipboards, etc. Likewise, there was no evident reason for changing the basic type font as used in the current standard Jeppesen charts. The recommended chart as shown in Figure 5, however, only simulates the typestyles and graphics produced on the current standard Jeppesen charts because it was not prepared by the Jeppesen Sanderson production facilities. It may therefore not be totally faithful to the actual appearance of a final chart.

The recommended chart is organized into the same major segments as the current standard chart: Heading, Plan View (map), Profile, and Minimums. The content of each segment may differ somewhat from the current standard chart, but the main purpose of each area remains essentially unchanged. In the following descriptions, therefore, changes in the design or location of each feature are referenced to the current chart. For example, the Minimum Safe Altitude (MSA) depiction is described as having been moved from the Heading to the Plan View. The following description of the recommended chart is organized into four sections corresponding to each of the segments noted above. Each section begins with a discussion of the purpose and general content of the segment; this is followed by the specific feature description and rationale.

4.3.1 <u>Heading</u>

The Heading of the chart is devoted primarily to a Briefing Strip which follows the basic approach used in the Volpe/ATA Prototype, including chart identification information as well as communication frequencies.

4.3.1.1 Chart Identification - The topmost line of the Heading contains the number, date and location name of the chart, unchanged from the current standard chart. This information is used for indexing the chart as well as in briefing the approach. The bolding of the chart number as done on the Jeppesen prototype is not included in the recommended chart since the comments relative to it were negative. The four-letter ICAO identifier is included in the identification segment as it was in the Jeppesen prototype by the virtually unanimous agreement of the pilots that it would be useful in international operations.

Prototype Chart - Not for Navigation
For Illustration Only - Data Not Necessarily Accurate

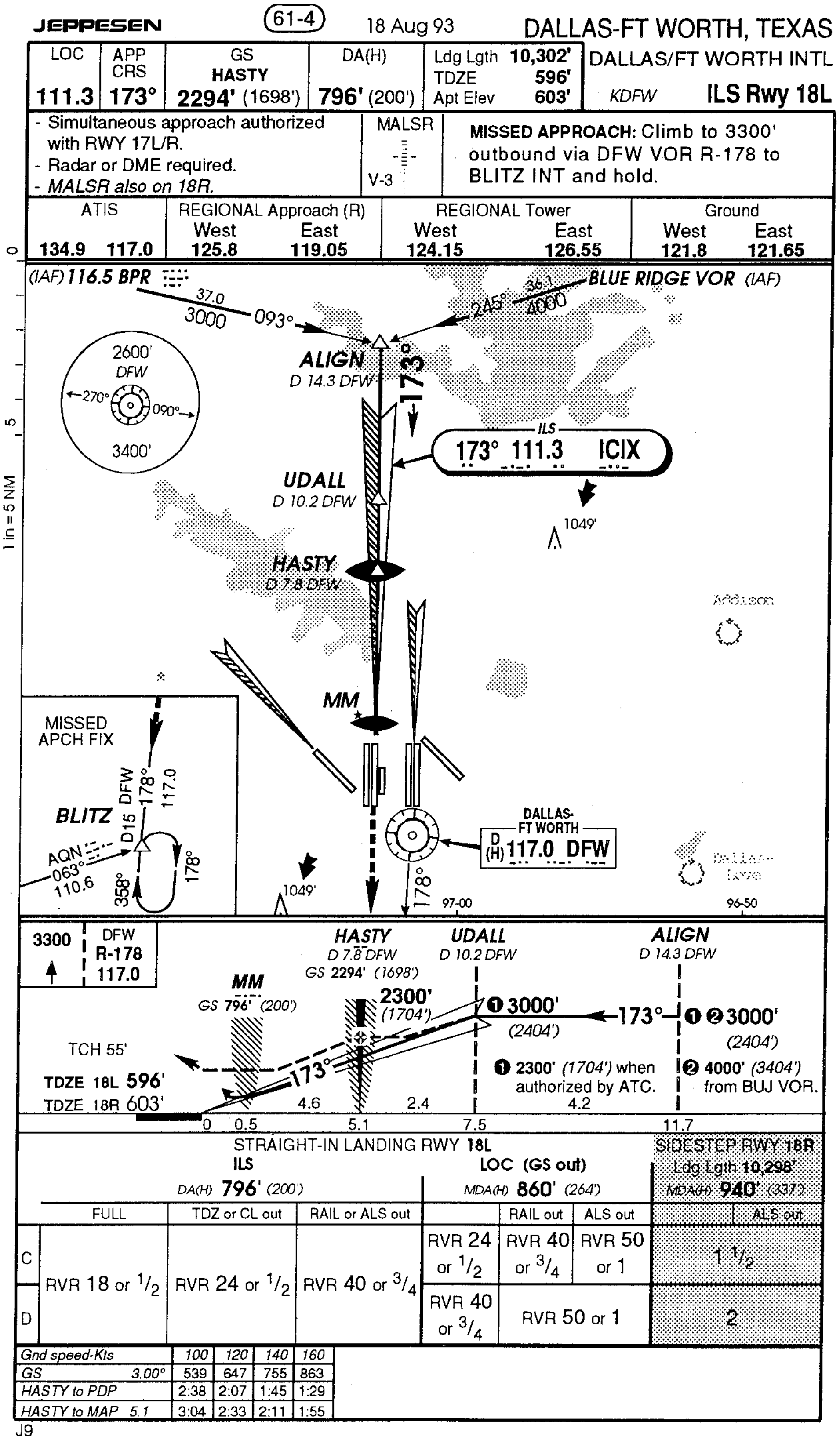


Figure 5. Sample of Recommended Improved Instrument Approach Procedure Chart for Dallas/Fort Worth International (DFW) ILS Runway 18L

4.3.1.2 Briefing Strip - The Briefing Strip occupies most of the Heading area. It consists of three lines of information arranged in boxes. The main part of the Briefing Strip is contained in the first two lines of information just below the identification. Virtually all of the pilots who used the Volpe/ATA prototype in the simulator as well as most of those who used the Jeppesen prototype or who did not fly the simulator at all endorsed the Volpe/ATA briefing concept. The organization of the information in a standard, order-of-use way was preferred by these pilots. However, several items needed for a briefing were identified as missing from the prototype strip. It was also noted that communications frequencies are not briefed and, therefore, their inclusion on the second line of the Volpe/ATA prototype Briefing Strip interrupted the flow of the briefing. As a result, communications information has been moved to the third line of the Briefing Strip.

The strip shown in Figure 5 for the recommended chart contains the set of information judged to be the most useful for approach briefings. In the first line of the strip, the information to be briefed is shown in bold type while the *name* of the information is shown in regular type. This has been done to emphasize the information that the briefing pilot will read. The first line contains the following information which is the consensus of the pilots' opinions of what is needed for briefing:*

- LOCALIZER FREQUENCY This information was moved from the chart identification section of the current standard chart where it appeared in small letters under the approach identification (see Figure 1). There was a moderate preference for including localizer frequency in the strip, and it was decided that since it is used in the briefing, it should be in the strip rather than being part of the approach and runway identifier as it is now. The frequency also appears in the Plan View adjacent to the approach course depiction as it does on the current standard chart and both tested prototypes.

- FINAL APPROACH COURSE This information was deemed to be useful in briefing the approach even though already shown in the Plan View (in characters and graphically). The rationale was that the inclusion of the final approach course in the Briefing Strip helps ensure that it will be briefed and reduces the need for a pilot to search the entire chart to obtain the information needed for a briefing.

- FINAL APPROACH CROSSING ALTITUDE The third box in the first row of the Briefing Strip contains a crossing altitude reference for ensuring altimeter accuracy and terrain clearance during the approach. This information is important in briefing both precision and non-precision approaches. The box is labeled on its first line based on the type of approach being made and the

---

*The actual content of a pre-approach briefing varies somewhat across air carriers. The information shown in the Briefing Strip is intended to cover the majority of cases and is based on the practices at the four carriers included in the study plus an additional airline for which two of the project subject matter expert pilots flew.

fix information it contains. Therefore, the box is designated "GS" in Figure 5 as the approach is an ILS approach and the reference would be cross-checked while the aircraft was on the glideslope. The second line contains the designation of the fix for the crossing altitude. This might be a Final Approach Fix (FAF) for a precision approach (as it is in Figure 5) or the Final Approach Point (FAP) for a non-precision approach. The crossing altitude (in both pressure--MSL--and above ground level--AGL) is shown on the third line of the box. This information is repeated in the Profile section of the chart for operational reference and consistency with current charts.

- DECISION ALTITUDE (DA) Virtually all of the pilots indicated that they brief the DA. In addition, it is an important reference item while flying the approach. Therefore, a box for the DA has been included in the strip and reference to it continues to appear in the Profile View. Current conventions for displaying altitudes are followed.

- RUNWAY INFORMATION On the current standard chart, airport elevation appears in the Heading area and TDZE is in the Profile segment. Runway landing length must be obtained from a separate Airport Chart. Each of these items is typically included in an approach briefing and therefore was incorporated in the Briefing Strip.

The second line of the Briefing Strip contains equipment and procedures notes, a depiction of lighting on the intended runway, and the missed approach procedure (MAP) narrative. Descriptions of these follow.

- NOTES There was a moderate to strong preference for placing all equipment and procedural notes in a single location. There was also agreement that notes dealing with navigation should remain in the Profile section as on the current standard chart. There was, however, no strong preference for where the equipment and procedures notes should be placed. The Briefing Strip was selected because it appears that all airline briefing procedures include a review of all notes. Each note is preceded by a dash as a delimiter character.

- RUNWAY LIGHTING The Volpe/ATA prototype included in its Briefing Strip a depiction of the Approach Light System (ALS) of the intended runway. There was a strong preference for this depiction over the present design where the lighting is found only on the Airport Chart. Based on discussions with the participating pilots, the configuration shown in Figure 5 was selected. The name (acronym) of the ALS is at the top of the box with a schematic diagram of the light pattern in the center of the box. If any visual glideslope indicators are used, they are also indicated. The presence of a Visual Approach Slope Indicator (VASI) is indicated by the letter "V." Its configuration is noted by the number of lights in the array and its position is conveyed by the location of the label. Therefore, in Figure 5 a three light VASI on the left of the runway is indicated by a "V-3" to the left of the ALS

symbol for the MALSR light configuration. A Precision Approach Path Indicator (PAPI) system would be similarly depicted with a "P" symbol. If a parallel runway has the same lighting system (with the resulting potential for confusion) an italicized note is placed in the Notes box as shown in Figure 5.*

- MISSED APPROACH PROCEDURE NARRATIVE This narrative is presented in the same format as in the current standard chart. The rationale for putting this narrative in the Briefing Strip is that all briefing procedures require that the narrative be read.

The bottom line of the Briefing Strip shows the frequencies of the communication facilities which might be used in the approach. In the current standard chart design, these occupy a substantial part of the Heading area. A virtually unanimous opinion of the participating pilots was that the printed frequencies were often different from those actually in use. Further, it was agreed that the frequencies are not used in briefing the approach. One suggested resolution was to move the frequencies to the bottom of the sheet. Because this was such a dramatic change, a compromise was made by putting the frequencies in a horizontal array at the bottom of the Briefing Strip. This kept them close to their traditional position but reduced the prominence given them in the current standard chart. Also, by making them the third line of the Briefing Strip rather than the second line as in the Volpe/ATA prototype, the flow of a briefing is not interrupted.

4.3.2 Plan View

In substantial part, the Plan View of the recommended chart adheres to the content and format of the current Jeppesen chart. There are, however, four significant modifications which will be described below:

- OBSTACLE AND AIRPORT INFORMATION Throughout this study, there was comment on the fact that approach plates must present a substantial amount of information within a relatively limited page size. A consequence is that parts of the chart become "cluttered" with symbols and/or alpha-numeric information which has the potential for interfering with both the speed and accuracy with which the user is able to obtain information. Both tested prototypes attempted to declutter the Plan View by reducing the extent to which obstacles and airports other than the intended destination are depicted. Virtually all of the pilots in this study expressed an initial preference for the complete decluttering of the Plan View on the Jeppesen prototype. Upon reflection and further discussion, however, the common conclusion was that *some* obstacle and other-airport information was needed. The research team

*The lighting and other data shown in Figure 5 are ***not*** necessarily accurate for the DFW ILS Rwy 18L approach. Various features were altered or added to this sample chart to demonstrate the IAP chart design recommendations.

in its final review of results arrived at the following reasonable compromise between the need for information and the preference for a decluttered chart:

- Criteria for selecting obstacles and airports to be shown in the Plan View will be the same as for the current standard chart. This means that no information will be completely deleted, and the data bases which support the current charts will remain valid.

- Obstacles within five nautical miles of the approach center line and the highest obstacle(s) on the chart will be printed in full intensity (i.e., without any screening of the obstacle symbol or its altitude label). The five nautical mile criterion was selected because it was the distance the designers of the Volpe/ATA prototype used for obstacle depiction. The study respondents were not generally in favor of deleting all airports and obstacles which were more than five miles from the approach course as on the Volpe/ATA prototype. Their comments did suggest, however, that five nautical miles from the approach course was a reasonable distance at which to make a transition, if one was to be included in a revised IAP chart design.

- The highest obstacles on the chart would continue to be designated by a solid black arrow pointing to their height as they now are on the current standard chart.

- All obstacles other than the highest obstacle(s) and those within five nautical miles of the approach course and the indication of airports other than the destination (regardless of their location) will be screened when printed to reduce their prominence and thus their potential for interference.

- MSA CIRCLE The MSA Circle has been moved from the Heading where it had traditionally been presented. Since it is essentially a *map* of the minimum safe altitude areas, it logically belongs in the Plan View. In the recommended design, the MSA Circle is allowed to "float" within the Plan View to occupy unused space. This was the Volpe/ATA prototype approach. The format of the MSA Circle follows the strong preferences for: defining the MSA facility by its type symbol ***and*** identifier; defining MSA sectors with radials rather than bearings; and completely identifying the altitudes rather than using abbreviated sectional chart notation.

- APPROACH COURSE The Plan View retains the basic depiction of the approach course found in the current standard chart. This has been enhanced by the adoption of the greatly preferred format used on the Jeppesen prototype. This format includes the use of bold type for the numerical value

of the course and for the names of the fixes. Also, a slightly larger numeral size is used to designate the approach course. Where possible, the fixes are aligned on one side of the center line making them easier to find and better depicting their sequence in the approach.

- MISSED APPROACH FIX The missed approach fix diagram is retained in the Plan View. Its content is unchanged from that included in the current standard chart and both tested prototypes. The format as used in the Jeppesen prototype has been adopted. The format changes are the use of larger type for the outbound course information (178° in Figure 5) and large, bold lettering for the missed approach fix (**BLITZ** in Figure 5).

4.3.3 Profile View

The Profile View in the recommended chart follows closely the current Jeppesen design. There are, however, four major modifications as described below:

- MISSED APPROACH NARRATIVE Because the primary use of this is in briefing the approach, it has been moved to the Briefing Strip. This was illustrated in the Volpe/ATA prototype and was preferred by virtually all of the pilots.

- MISSED APPROACH ICONS These pictorial/graphic depictions of the initial steps of the missed approach were a chief feature of the Volpe/ATA prototype. They were given enthusiastic approval in this study, particularly by those pilots who used the prototype in a simulator. Specific features of these icons were derived from the preferences of the pilots in this study. These are shown in the recommended chart illustration (Figure 5) and described below:

    - Each icon depicts a single act such as "Climb to 5,000 feet."

    - The orientation is as though the aircraft is at the bottom of the icon flying toward the top.

    - The critical information in each icon, e.g., the altitude or the radial, is bolded.

    - The symbology used within the icons will be conformed with that currently used on Sectional Charts. The main difference between this notation and the symbology tested with the Volpe/ATA prototype are the symbols used to denote climbs or descents "to or below (above)" a given altitude.

    - The entire set of icons will be targeted only at the maneuvers needed to get the aircraft up and away from the airport. This is approximately the first two minutes after the Missed Approach Point.

- BOLD TYPE The extensive use of bold type on the Jeppesen prototype was preferred by the pilots over the current chart typography. Bold type is used in the Profile View to emphasize the fix names, arrival and crossing altitudes, and the TDZE of the intended runway.

- CIRCLE-TO-LAND DEPICTION The modified circle-to-land depiction used in the Volpe/ATA prototype is recommended. This format is not shown in Figure 5 since it does not apply to the particular approach shown. However, examples can be found in Appendix B on Volpe/ATA prototype depictions of the two Chicago O'Hare and the two Denver Stapleton approaches.

4.3.4 Minimums Area

This section of the recommended chart is little changed from the current standard chart. The landing length of a sidestep runway is included to be consistent with the type of information contained in the first row of the Briefing Strip. Bold type is used, as preferred by the pilots, to denote important information: decision altitudes and the sidestep runway length. The entire section devoted to the sidestep runway is shaded to help the pilot to find that information quickly in the event of a sidestep and to differentiate it from the minimums for the primary runway. Finally in this bottom section of the chart, the ground speeds used in the calculations of time to Missed Approach Point have been limited to the categories of 100, 120, 140, and 160 knots, and Aircraft Approach Categories "A" and "B" have been eliminated. This deletes the 70 and 90 knot columns found in the current standard chart and should ensure that all types of aircraft used by air carriers are included. Further, the calculation of time from the final approach fix (or final approach point for non-precision approaches) to the Planned Descent Point (equivalent to the Visual Descent Point for non-precision approaches) has been added to supplement the calculation of the time to the Missed Approach Point. These calculations were strongly suggested by the pilots' comments as well as the analyses of the project staff.

4.4 DISCUSSION

The recommended chart format is based on the data from this study, the judgments of the study staff and inputs from the ATA Chart and Data Display Working Group. The content and format rules for the chart have also been discussed with personnel from Jeppesen Sanderson. Time and resources have not permitted an assessment of the applicability of the recommended charting method across all airports and approaches which must be covered. The recommended chart does not represent a radical departure in *content* from the current standard chart. Its *format*, however, is a significant change in the Heading area and some parts of the other segments of the chart. Therefore, adjustments in the recommended format may be required to accommodate airports and approaches with unusual characteristics.

If the recommended chart is adopted, it is reasonable to ask whether it can be phased in gradually or whether all existing Jeppesen-type IAP charts must be changed simultaneously. This issue was discussed at length with the pilot/respondents in the study,

many of whom were involved in training for their airlines. The virtually unanimous consensus was that there should be no problems with the gradual introduction of a new chart similar to the tested prototypes. The 81 pilots who flew simulator trials were able to alternate between the current standard chart and one of the prototypes without difficulty *on successive approaches*. There was some concern expressed that a late runway change requiring a change in charts could be a problem if one chart was the current standard and the other was a new design. Therefore, it is recommended that all of the approach charts for an airport be updated at the same time when the new chart design is phased in.

The issue of additional training requirements for the prototypes was also discussed with the study participants. In general, they felt that neither of the tested prototypes would present a significant training load. By inference, the recommended chart should therefore not require additional training since it is an amalgam of the Volpe/ATA and Jeppesen prototypes and retains many of the features and format of the current standard chart. It was suggested by the participants, however, that a good briefing of the chart features and a reference document should be distributed when the new chart is introduced.

The issue of whether the recommended chart changes could be extended to commuter air carriers and to general aviation pilots was also discussed. The general feeling was that air carrier and commuter operations are becoming more closely allied, particularly with ownership of commuter airlines by major air carriers and with code-sharing arrangements. Therefore, an extension to commuter operations should not be an issue. The use of the recommended chart by general aviation pilots has yet to be explored. Even though many of the study participants fly general aviation aircraft, they are hardly typical of the full range of general aviation pilots. The concepts introduced in the recommended chart, however, should be beneficial to rapid and accurate acquisition of information in general aviation operations. Even the Briefing Strip, which is designed to enhance crew interactions during an airline approach briefing, should be of value in single pilot operations. More analysis of the use of the recommended chart by general aviation pilots is needed, and the consequences on clutter and spacing of reinstating Aircraft Approach Categories "A" and "B," which would be required for general aviation, must be considered.

Finally, changes in the format or production methods of the current Jeppesen-type charts other than those covered above and shown in Figure 5 are specifically ***not*** recommended. The paper, typestyles, line weights, binding techniques, etc. used by Jeppesen Sanderson are familiar to airline pilots and easily accommodated by them. Any alteration of these features without the type of supporting information produced by this study could reduce the acceptability and/or the effectiveness of IAP charts.

5. REFERENCES

Gopher, D. and Braune, R. (1984). On the psychophysics of workload: Why bother with subjective measures?, *Human Factors*, Vol 26, 5, pp 519-532.

Hansman, Jr., R.J. and Mykityshyn, M.G. (1990). *Current issues in the design and information content of instrument approach charts*, (Report No. ASL-90-1-1) Aeronautical Systems Laboratory, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology.

Kuchar, J.K. and Hansman, Jr., R.J. (1992). *Advanced terrain displays for transport category aircraft,* (Report No. DOT/FAA/RD-92/4). Cambridge, MA: Aeronautical Systems Laboratory, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology.

Mangold, S.J., Eldredge, D. and Lauber, E. (1992). *Human factors design principles for instrument approach procedure charts: Volume I, Readability,* (Report No. DOT/FAA/RD-92/16,1). Cambridge, MA: U.S. Department of Transportation, Volpe National Transportation Systems Center.

Multer, J., Warner, M., DiSario, R.M. & Huntley, Jr., M.S. (1990). *Design considerations for IAP charts: Approach course tracks and communication frequencies,* (Report No. DOT/FAA/RD-91/19). Cambridge, MA: U.S. Department of Transportation, Volpe National Transportation Systems Center.

Mykityshyn, M.G. and Hansman, Jr., R.J. (1990) *An exploratory survey of information requirements for instrument approach charts,* (Report No. ASL-90-1-2). Cambridge, MA: Aeronautical Systems Laboratory, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology.

Osborne, D.W. (1988). *Psychophysical assessment of the perceived print quality of electrophotographic printers* (Doctoral dissertation, University of South Dakota, 1988) *Dissertation Abstracts International*, 49, 4584B.

Osborne, D.W. and Huntley, Jr., M.S. (1992). *Design of instrument approach procedure charts: Comprehension speed of missed approach instructions coded in text or icons,* (Report No. DOT/FAA/RD-92/3). Cambridge, MA: U.S. Department of Transportation, Volpe National Transportation Systems Center.

APPENDIX A

IAP Chart Study Protocol

Study Protocol

for

Instrument Approach Procedure Charts Evaluation

Overview

The overall objective of this study is to evaluate two proposed Instrument Approach Procedure (IAP) chart prototypes based on data/information collected from participating Part 121 pilots. This evaluation will be based on the systematic determination of the following:

- Pilot's assessment of the speed and accuracy with which they could acquire and use the information contained on these charts.

- Pilots' preference for the unique features of each prototype (including the basis for these preferences).

- Pilots' preference for each prototype relative to the current "standard" chart, i.e., Jeppesen type. This preference will be obtained on the assumption of an approach to an unfamiliar airport.

In addition, this study encourages pilots to suggest further changes in the format and content of IAP charts. The sample of pilots will be provided by four participating air carriers (Continental, Delta, Northwest and United). The sample will include Captains as well as First and Second Officers and will include a range of experience in a number of current aircraft. The carriers will also provide simulator time for approaches to be made with each of the two prototypes as well as with the current standard. The pilots will fly approaches using procedures prescribed by their own line. Observations will be made by the VNTSC/Battelle/Dunlap research staff, and preference and opinion information will be collected from the users. No measures of performance will be taken.

This study will be conducted by four Research Teams, each consisting of a human factors specialist and a retired Part 121 Line Captain. The human factors specialist will be the team leader, and will be responsible for the aspects of the study relating to the ways in which the user acquires and processes information from the charts. The Line Captain will be responsible for explaining and assessing the operational aspects of chart use. This division of responsibility is based on the professional capabilities of the each team member but it also reflects the fact that the study divides naturally into "content" or operational issues and "format" or human factors issues.

The prototypes that are the subject of this study are the Volpe National Transportation Center (VNTSC) Prototype, and the Jeppesen Revision. The former was developed on the basis of inputs from the Air Transport Association (ATA) and laboratory studies conducted by VNTSC. The Jeppesen Revision is the product of that company's continuing research into chart usage and design. The current Jeppesen chart will also be used in the study for

comparison. The features of each prototype will be described, but, in order to avoid bias, sponsorship of the design of specific chart types will not be identified.

Each pilot will be asked for preference and opinion information about all three types of charts. All of the pilots will fly approaches with one of the prototype charts and with the standard in a 2 hour simulator session. Because one line schedules only 4 hour blocks, each of their pilots will fly approaches with all three charts.

Data Collection Procedures

As noted earlier the approach to this study has developed into a structure that reflects the functional grouping of the information shown on IAP charts as well as the content and format of each such group. This structure applies to, and has been used in, each of the data collection procedures. It is important conceptually, yet it is a simple construct. It is based on a functional grouping of all of the informational elements that must appear on any IAP chart, whether in text, i.e., words and numbers, or graphic/pictorial representation. Each of these informational elements can be thought of in terms of its content and its format. In other words, what is shown on the charts, and how it is presented. The former issue is essentially a functional one--the charts must present what is needed to accomplish all of the approach functions. Content, in other words, can be considered a "pilot issue." Format, on the other hand is a human factors issue which concerns the question of how well does each "display" meet the requirements and limitations of the crew in terms of perception and cognition and facilitate the speed and accuracy of information transfer. These human factors concerns are also affected by the crew's procedure for using these charts, the cockpit environment (e.g., lighting) and the operational environment, including weather, time of day, traffic conditions, etc.

The information categories can be thought of as one axis of a matrix, the other of which consists of the content/format dimension. This is illustrated on the next page. It will be noted throughout this study that there are two distinct functions in which the IAP chart is used. The first is briefing the approach, i.e., the planning that takes place in the cockpit. The second is executing the approach or the missed approach. These functions will be referenced in the questions and the cues used by the Research Team. For example, every time a pilot is asked how accurately an information category (on a specific chart) can be interpreted, he or she will be prompted to consider both briefing and execution.

Instrument Approach Procedure Chart Data Collection Matrix

Information Categories	Content	Format
Communications		
Navigation Aids		
Horizontal Navigation		
Vertical Navigation		
Missed Approach Procedure		
Minimums		
Notes		

The concept of this matrix is reflected throughout this study, and it will be seen in each of the data collection forms and procedures.

Activities to be performed during each data collection session are listed in sequence on the following page. Form numbers identify data collection and guidance documents for specific activities at each test site, i.e., each airline.

Please write any comments on problems with the data collection process or specific suggestions from the crew directly on the forms. All forms for a particular airline and crew will be provided in a pre-numbered manila jacket. The numbering convention used is:

1st digit (1-5) = Airline

1 = Continental
2 = Delta
3 = Federal Express
4 = Northwest
5 = United

2nd and 3rd digit (01-10) = Crew

4th digit (letter) = Crew member

A = Captain
B = First Officer

NOTE: IF THE CREW IS NOT A LINE CREW WITH A DEFINED CAPTAIN AND FIRST OFFICER, JUST ASSIGN THE LETTERS A AND B ARBITRARILY.

Thus, a crew designation of **0304A** would indicate the Captain of the fourth crew at Federal Express.

It is important to use the assigned number on any additional or substitute forms. After data collection, place all forms, notes and the video tape(s) in the jacket for that crew.

The forms listed in the table on the next page will all be found in the data collection jacket. Some of these forms are to be handed to the pilots. Others are for your guidance as you conduct your part of the data collection. Three types of information are contained on these forms:

> ❑ **Action items to remind you of points in the process which must be covered**
>
> *Examples of presentation approaches. These items in italics are for your reference and preparation before data collection. They should not be read to the crews.*
>
> NOTES ABOUT DATA COLLECTION PROCEDURES

The forms are numbered sequentially in the order of their use. The Form and page number are shown at the bottom of each page as follows:*

4-2

would indicate page 2 of Form 4.

Use of Video

Each team will have a video camcorder and tripod for use during data collection. The points in the data collection sequence at which the video is to be turned on and off are shown on the next page and as an action item on the appropriate forms. Detailed instructions in the use of the provided camcorders are included as part of this instruction package. They are not duplicated in each data collection jacket.

---

*The described numbering sequence was the one used during data collection. For purposes of this report Appendix, the pages have been sequentially numbered and the form and page number have been printed at the bottom of each page.

Sequence of Study Activities

ACTIVITY	FORM #
Arrive on site and prepare location for data collection	1
Introduce research team. Obtain Agreement to Participate forms from crew.	2, 3
Administer Background Information form to obtain crew experience data and approach chart acceptance information.	4
Turn on video. Note start time on Form 5 - Video Log	5
Review the background responses using the Matrix	6
Brief crew on study	7
Describe 1st Prototype (odd crew number = VNTSC; even number = Jeppesen)	8V, 8J
Turn off video. Note stop time on Form 5 - Video Log	5
Determine if the crew feels ready to use the prototype	9
Go to simulator. Give instructions (Form 10) and schedule to operator	10
Conduct Sim session (Nominal time is 2 hours). Record sim session data using Forms 12 and 13 (12 for the pilot and 13 for the human factors specialist)	11, 12, 13
Return to briefing area -- 5 minute break.	-
Collect scaled data on the flown Prototype	14J, 14V
Describe 2nd Prototype (odd crew number = Jeppesen; even number = VNTSC)	8J, 8V
Determine if the crew feels ready to use the prototype	9
Collect scaled data on the Second Prototype	14J, 14V
Conduct Direct Scaling comparison among all three charts	15
Conduct Role-playing evaluation ("decision to buy")	16
As time permits, return to simulator and fly approaches with the Second Prototype	17, 12, 13
End of session discussion, including thanks and taking questions	18

Set-up Instructions

On the first visit to each site, we have to make certain of the following:

- ☐ **Confirm that we have permission from the line to use our video cameras. We will also have to check with each crew to be sure that they have no personal objection. If they do we will run the camera just to get the audio--leave the lens cap on, or aim it at a wall. We will need two blank video tapes for each crew. Be sure to label these with the airline and crew number (3 digits).**

- ☐ **Identify, and locate the simulator(s) we will be using.**

- ☐ **Review approaches and simulator schedule with points of contact and simulator operators.**

- ☐ **Check for chairs, table, chalk board (or equivalent), easels for large chart displays (24" x 30"), power outlets, power cord, and pencils, etc. No doubt we will bring some of this with us.**

- ☐ **Rules of the house, such as: security, access to other areas, break cycles for the crews, storage for our equipment, etc.**

- ☐ **Facilities for food, coffee, telephone messages, etc.**

- ☐ **Arrange, or plan to arrange the room for our briefing and data collection. Where do we stand or sit relative to the crew and the board, easel, etc.**

- ☐ **Names and telephone numbers of personnel responsible for our use of the facility**

- ☐ **Find out if we have to monitor the crew schedule, and what is the procedure?**

- ☐ **What do we do with ourselves and our paraphernalia between crews--we will have to work out a way of moving from one simulator to another since the briefing rooms are "dedicated" to particular simulators. Make sure that everything is safe and that other potential subjects cannot get access to the prototype charts while we are not around.**

Protocol Form: *1*

Crew ______

Initial Activities

☐ **Confirm that the set of forms is numbered correctly**

☐ **Introduction**

Good Morning, I'm Ed Bishop my company is Dunlap and Associates--a human factors research and consulting firm in Connecticut. My partner today is Jim McIntyre who has retired from TWA where he most recently was a 747 Captain. Jim now consults in aviation safety and is an experienced crash investigator.

We are here today on a study of approach plates that is being coordinated by the Volpe National Transportation System Center (a part of the Federal Department of Transportation) in support of the FAA and the ATA Charting Committee. We would like to videotape this session so that Jim and I can spend our time listening and interacting with you rather than taking notes. Your name will not be associated with the video, but we need your permission to make the tape and for the research sponsor to use parts of it in publicizing the study. We also will be asking you for some creative ideas as we go along. We do not want you to tell us anything which may be confidential or proprietary to your company or anyone else you might be working with. We need you to sign a statement indicating that we have your permission for taping and that we can use any ideas you give us today.

☐ **Get signature on Agreement to Participate Form (Form 3)**

In a couple of minutes we will tell you more about the study, and exactly what we are going to be doing today. Right now, we want to get a little bit of information about your background and some idea of how you feel about the current approach plates.

This study is not concerned with your performance, and it is being kept anonymous: please do not put your name or other identification on any of the data forms we will be using today. They will be numbered just to keep all of your input together.

Protocol Form: *2 page 1*

- ☐ **Display Jeppesen current standard chart (green dots) and give a large copy to each of the crew**

- ☐ **Pass out Background Information Form (Form 4)**

Please complete all questions on this form. The top part contains a few questions about your flight experience.

The lower part of this form asks for some opinions about current approach plates. We have copies (and an enlargement) of the Jeppesen for Dallas Fort Worth ILS-1 Rwy 18L. We are not evaluating this particular approach plate, it's only a current example for your reference. In responding to the two questions on your form: one asks for your opinion about the potential for improved performance if the <u>content</u> of current charts were to be changed, the second asks for your opinion about the potential for improved performance if the <u>format</u> were to be changed. By "content", of course, we mean what is shown on the chart; and by "format" we mean the way in which it is shown.

Beneath each of these questions, there is a scale on which we want you to indicate where your answer would fall. Please choose one of the points on the scale that corresponds to your estimate of how much potential for improvement there is. Please circle the number that you feel best represents your opinion. You must pick one of the numbers. You cannot make a choice between numbers.

Please do each scale separately. For this kind of scaling, it is probably best to go with your initial reaction, but take as much time as you wish to think about the scale and review the sample chart.

- ☐ **Turn on video - log start time on Form 5 (if used)**

Crew ______

Agreement to Participate

The Volpe National Transportation Systems Center (VNTSC) of the U.S. Department of Transportation is sponsoring an Instrument Approach Procedure (IAP) Chart Study in support of the Federal Aviation Administration (FAA) and the Air Transport Association (ATA) Charting Committee. You have been asked by your air carrier to volunteer to participate in this study. As a study participant, you will be asked for your opinions concerning existing Instrument Approach Charts and how to make them better. You will also be asked to fly some approaches in one of your company's flight simulators as part of the chart assessment. You are not being evaluated, and any information you provide will be kept completely anonymous.

The study is being conducted by a team of contractors to VNTSC including Battelle Columbus, Dunlap and Associates, Inc. and EG&G Dynatrend with the approval and cooperation of your company's management. Personnel from these organizations will serve as briefers and data collectors. As a participant, we ask that you agree to the following conditions:

- You will not reproduce or distribute any of the charts you are asked to evaluate. You will also not discuss the study procedures or materials with any other pilots within your company until the data collection is completed.
- When providing your responses and opinions, you will not divulge any information which is confidential, proprietary or otherwise restricted from general public dissemination. We will assume that any information you provide can be freely released.
- Any ideas, designs or suggestions you volunteer will become the property of the U.S. Government, and you release all rights to them.
- You agree to being videotaped as part of the data collection process. Any tapes recorded will be used for purposes of data analysis and erased when analyses are complete.

By signing this form you agree to the conditions stated above.

____________________ Date	____________________ Participant Signature
____________________ Study Team Member	____________________ Printed Name

Protocol Form: ***3***

Crew ______

Background Information

Please fill in the following background information. Do not put any identification on this form.

Total flight hours ____________ ATP qualified: Yes ☐ No ☐

Current Type Qualification ______________________ Hours in type ________

Other aircraft qualifications ____

Have you flown a single pilot IFR approach in the last 6 months? Yes ☐ No ☐

Of all approaches you've flown in the last 6 months, what percent were with:

NOS charts _____% Military charts _____% Jeppesen Charts _____%

Please circle the one number on each scale which best represents the answer you would give to each of the two questions below.

How much do you think current Jeppesen-type approach plates could be improved by changing their content (i.e., the kind and amount of information they contain)?

Very Little					**Very Much**
1	**2**	**3**	**4**	**5**	**6**

How much do you think current Jeppesen-type approach plates could be improved by changing their format (i.e., the way information is presented)?

Very Little					**Very Much**
1	**2**	**3**	**4**	**5**	**6**

Protocol Form: *4*

Crew _______

Video Log

Time	Event	Comments
	Video On	

Protocol Form: 5

Crew ______

Review of Background Information

☐ **Begin discussion of scale data on Background Information Form**

THE FOLLOWING SCRIPT AND REVIEW PROCEDURE WILL BE USED BEFORE THE STUDY IS BRIEFED TO THE CREW. THE ATTITUDE HERE HAS TO BE THAT WE ARE LOOKING FOR OPINIONS ON THE CURRENT IAP CHARTS. THIS WHOLE REVIEW SHOULD MOVE QUICKLY. WHAT WE NEED HERE IS PRIMARILY THE INITIAL REACTION TO EACH OF THE TOPICS: WE DON'T WANT TO GET INTO A DETAILED DISCUSSION OF CHART FEATURES AT THIS TIME. THIS WILL REQUIRE SOME JUDICIOUS HANDLING OF COMMENTS AND QUESTIONS FROM THE CREW. WE HAVE TO AVOID GETTING BOGGED DOWN IN A LOT OF DISCUSSION OF DETAIL (AND "WAR STORIES") YET LET THE CREW FEEL THAT WE ARE SERIOUSLY INTERESTED IN WHAT THEY HAVE TO SAY. WE WILL BE ON AN INFLEXIBLE SIMULATOR SCHEDULE AND CANNOT WASTE TIME IN THIS INITIAL PART. AT THE END OF THE SIMULATOR SESSION THERE WILL BE TIME FOR MORE DETAILED DISCUSSION--COULD BE UNLIMITED, DEPENDING ON WHEN THE NEXT CREW IS SCHEDULED. SO, MOVE THIS REVIEW AT A QUICK PACE BOTH TO GET SPONTANEOUS REACTIONS AND TO AVOID MISSING PART OF OUR SIMULATOR TIME.

We are going to spend a few minutes now talking about the current IAP charts, and the opinions you have just put down about the potential for improvement.

First, lets look at this matrix which illustrates the way in which we have been thinking about approach plates in general.

☐ **Give each pilot a copy of the matrix and put the enlarged copies on the table. The matrix is included here too, for your reference and note taking.**

Instrument Approach Procedure Chart Data Collection Matrix

Information Categories	Content	Format
Communications		
Navigation Aids		
Horizontal Navigation		
Vertical Navigation		
Missed Approach Procedure		
Minimums		
Notes		

Protocol Form: ***6 page 1***

Crew ______

This structure shows the functional grouping of all of the informational elements that must appear on any IAP chart, whether in text, i.e., words and numbers, or graphic/pictorial representation. Each of these informational elements can be thought of in terms of its content and its format. In other words, what is shown on the charts, and how it is presented. The former issue is essentially a functional one--the charts must present what is needed to accomplish all of the approach functions. Format, on the other hand is a human factors issue which concerns the question of how well does each "display" meet the requirements and limitations of the crew in terms of perception and cognition. These human factor concerns are also affected by the crew's procedure for using these charts, the cockpit environment (e.g., lighting) and the operational environment, including weather, time of day, traffic conditions, etc.

What we would like to do now is to go through these functional groupings and review the opinions you just recorded about the potential for changes in the current charts.

☐ **Read the scale responses made by each of the crew.**

☐ **Ask for comments about the existing Jeppesen-type charts in regard to each cell of the matrix.**

PLACE THE LARGE MATRIX ON THE TABLE AND PLACE A MARKER IN THE FIRST BOX TO DENOTE THE AREA BEING DISCUSSED.

MOVE THE MARKER AS YOU REQUEST COMMENTS FOR EACH AREA.

COMPLETE THE DISCUSSION OF EACH ROW BEFORE MOVING DOWN TO THE NEXT.

REFERENCE YOUR QUESTIONS AND PROMPTS TO THE CREW'S ANSWERS, E.G.:

You both agreed that the chart content could be improved. Would this apply to the communications information?

You both felt that there would be little benefit from a format change in the charts. Do you feel that way about missed approach information?

You disagreed considerably about possible benefits from format changes to the current charts. Why don't you discuss your differences for a few minutes while we listen in.

Crew _______

IAP CHART STUDY DATA COLLECTION MATRIX

Information Category	Content	Format
Communications		
Navigation Aids		
Horizontal Navigation		
Vertical Navigation		
Missed Approach Procedure		
Minimums		
Notes		

Protocol Form: *6 page 3 Matrix*

Crew ______

IAP Chart Evaluation Study Briefing

☐ **Describe study background**

This study is being coordinated by the Volpe National Transportation System Center of the U.S. Department of Transportation with the support of the Air Transport Association. Funding has been provided the Human Factors Research group of the Federal Aviation Administration.

Our overall objective is to evaluate a prototype of a proposed Instrument Approach Procedure (IAP) chart. In this evaluation, we will consider:

- *Your assessment of the speed and accuracy of acquiring and using approach information*
- *Your opinion of the design features of the prototype, and your preference for the prototype or the current standard chart features*
- *Your comparison of the prototype to the current standard chart--assuming an approach to an unfamiliar airport.*

We also will give you the opportunity to suggest specific changes in or additions to both the format and content of IAP charts.

Four airlines (Continental, Delta, Northwest and United), represented on the ATA Charting Committee, are participating in this study. They will provide a sample of crews with varying levels of experience as well as different type qualifications.

☐ **Describe basic data collection activities and schedule**

Each crew will fly up to 10 simulator approaches and respond to some questionnaires, but no performance measures will be collected. We will be making some observations and will record your suggestions and comments. We expect that the entire process, including about two hours in the simulator, will take about 4½ hours.

Protocol Form: 7

Crew ______

Prototype Description

☐ **Display Jeppesen Prototype (blue dots) and give a large copy to each of the crew.**

☐ **Introduce concept of a prototype IAP**

You each have an enlarged copy of a prototype Instrument Approach Chart for the Dallas Fort Worth International ILS-1 Rwy 18L approach (that's the same approach that we have displayed in the current format). This sample illustrates a proposed design intended to improve the speed and accuracy with which pilots can locate and comprehend information from an IAP chart.

Making an instrument approach requires a lot of information, and that information is used during a high workload period (when the crew is preparing for and carrying out an approach).

☐ **Introduce the philosophy of the prototype design**

This prototype chart focuses on design changes in the following seven areas:

- *The format of the information contained in the Heading of the chart*
- *The presentation of Minimum Safe Altitudes*
- *The presentation of Communications information*
- *The format and content of the information in the Plan View (Map)*
- *The format and content of the information in the Profile View*
- *The format of the Missed Approach description*
- *The format and content of Minimums information*

☐ **Describe the HEADING and its information**

The Heading contains the information needed to prepare for (brief) the approach. This information may also be referred to during the execution of the approach. The information is arranged vertically in order of use, from top to bottom. Specific features that enhance the information in the Heading are these:

- *The frequency and call sign of the primary navaid are shown in a large, bold type.*
- *The 4-letter ICAO airport identifier is shown next to the airport elevation for use in preparing for the approach, especially in FMS applications.*
- *The chart index number is shown in a large size, bold typeface.*

Protocol Form: ***8J page 1***

Crew ______

☐ **Describe the presentation of MINIMUM SAFE ALTITUDE**

- *The Minimum Safe Altitude (MSA) is shown in a circle containing the applicable sectors. It is incorporated into the Heading of this prototype for use in preparing for the approach.*
- *The MSA origin point is symbolized in the center of the circle, and the name of the facility marking the origin is shown adjacent to the MSA circle that depicts the sectors.*
- *The MSA sectors are shown as radials or bearings outbound from the origin point.*
- *The MSA are shown in a type style similar to Maximum Elevation Figures (MEF) and Minimum Off Route Altitudes (MORA) which are functionally similar values.*

☐ **Describe the COMMUNICATIONS information**

The Communications information is displayed in the Header in a sequence determined by their order of use, and by their geographical assignment (if appropriate). Large and bold type is used for emphasis. The specific features include:

- *The communication services are arranged vertically in sequence of use. The names of the services are shown in a column on the left side. The frequencies are shown on a horizontal line following the names in order of primary-secondary or by geographic sector in order of west/east or north/south.*
- *Frequencies are shown in a large, bold typeface.*

☐ **Describe the PLAN VIEW (MAP) information and format**

The plan view on this prototype contains only the information directly involved in the approach. Information that is available from other sources is not shown, and appropriate means of emphasis have been used. The specific features of this map view are as follows:

- *The plan view does not include obstruction information.*
- *Secondary IFR airports that are within 1 nautical mile of the approach course are shown.*
- *The runway diagram of the primary airport is highlighted by a screened circle.*
- *The information about the primary navaid is shown in a large and bold typeface.*

Protocol Form: ***8J page 2***

- *All of the information about the final approach course, including the diagram has been made larger and bold type has been used to further emphasize the markers and intersections as well as the navaid frequency and identifier.*

- *The plan view contains a "notes box" which contains both equipment and procedural notes. It is located generally in the upper right area of the map near the approach course heading.*

☐ **Describe the PROFILE VIEW information and format**

The Profile View contains the information traditionally shown in this part of an approach plate. Emphasis has been added by the use of large and bold type. The following are the significant design features in this area of the plate:

- *The Missed Approach Point for a non-precision approach is designated by the letter "M" in bold type.*

- *All of the alphanumerics used in the profile area are shown in large, bold type.*

- *All notes applicable to the descent are included in the profile area of the chart.*

☐ **Describe the MISSED APPROACH description**

The missed approach procedure is located directly below the profile section of the chart, and important information is emphasized through the use of a large, bold typeface.

☐ **Describe the MINIMUMS**

All of the altitude information in the minimums part of the chart has been shown in large, bold type. This includes both minimum descent and decision altitudes. The runway numbers have been similarly emphasized. The "MM out" information is no longer required to be shown.

Crew ______

Prototype Description

☐ **Display Volpe Prototype (red dots) and give a large copy to each of the crew.**

☐ **Introduce concept of a prototype IAP**

You each have an enlarged copy of a prototype Instrument Approach Chart for the Dallas Fort Worth International ILS-1 Rwy 18L approach (that's the same approach that we have displayed in the current format). This sample illustrates a proposed design intended to improve the speed and accuracy with which pilots can locate and comprehend information from an IAP chart.

Making an instrument approach requires a lot of information, and that information is used during a high workload period (when the crew is preparing for and carrying out an approach).

☐ **Introduce the philosophy of the prototype design**

This prototype chart focuses on design changes in five areas. The areas are:

- *The formatting of information needed during the crew briefing of the approach*
- *The presentation of minimum safe altitudes*
- *The presentation of information in the plan view (map) portion of the chart*
- *The presentation of information in the profile view*
- *The presentation of minimum descent altitudes*

☐ **Describe the BRIEFING STRIP and its information**

With regard to the first of these areas, the prototype shows the information needed to prepare for the approach in three panels or rows of information at the top of the chart. We refer to this as the BRIEFING STRIP which presents information in essentially the same order in which it is used during the approach. The top row of that strip shows the following from left to right:

- *Type, frequency and call sign of approach course navaid*
- *Approach course radial/heading*
- *Final Approach Fix altitude*
- *Touchdown Zone Elevation (both TDZEs for non-precision operations into parallel runways)*

In the second row, the following information is shown, also from left to right:

- *Automatic Terminal Information Service (ATIS) arrival frequency*
- *Approach Control frequencies*
- *Tower frequencies*
- *Ground Control frequencies.*

The third row contains:

- *Special notes*
- *A symbol depicting the runway lighting system*
- *A description of the missed approach procedure*
- *The Airport Elevation.*

The BRIEFING STRIP is a compilation of all of the information needed to brief the approach and/or program a flight management computer. The location of each type of information has been standardized, and critical information is emphasized with the use of boldfaced type. The arrangement of communication frequencies is in order of use.

❑ **Describe the MINIMUM SAFE ALTITUDE CIRCLE**

Minimum safe altitudes (MSAs) are shown in the MINIMUM SAFE ALTITUDE CIRCLE relative to a reference navaid, which is identified by its call sign. The sectors are defined by the radials rather than by magnetic bearings. The MSA, by definition, provides at least 1000 feet clearance above all obstacles in a 25 nautical mile radius of the navaid. Altitudes are shown in thousands and hundreds by large and small numerals as on Sectional Charts.

❑ **Describe PLAN VIEW (MAP)**

Only obstruction altitudes within 5 miles of the approach course are shown since those outside 5 miles are accounted for in the MSA. Likewise, only airports within 5 miles of the approach course are shown. However, the controling obstacle which governs the charting of the approach, is always shown regardless of its distance from the approach course.

The middle marker symbol and the Morse Code for the primary navaid have been deleted. The middle marker symbol is retained in the Profile View, and the Morse Code is contained in the Briefing Strip.

Crew ______

☐ **Describe PROFILE VIEW**

In the profile view, the "up and out" portion of the missed approach instructions is depicted by graphic symbols referred to as icons. These instructions can (and commonly will) be superseded by radar control, but the icons give the pilot the information that he or she needs to initiate the published missed approach procedure.

The TDZE of the intended runway is bolded.

☐ **Describe changes in MINIMUMS presentation**

Boldfaced type is used here to emphasize the decision altitudes for a straight-in approach.

☐ **Conduct icon training**

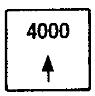
Protocol Form: ***8V page 3***

Crew ______

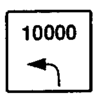
The Use of Icons for Missed Approach Instructions

Icons used to depict instructions for executing a missed approach combine symbols and alphanumerics in place of written instructions. The icons are created according to a set of rules comparable to a grammar or syntax for written language. The purpose of today's training is to familiarize you with these rules, and show you some examples. This will take only a few minutes, and should enable you to read the icons that are used on the prototype charts that you will be using in the simulator today. On those charts, only the initial part of the missed approach procedure is shown by icons, i.e. only the "up and out" maneuvers.

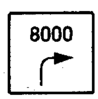
The first icons we'll look at are those that depict *climb* or *climb and turn*. In these icons, the direction of flight is indicated by an arrow at the bottom of the frame. Heading information is shown immediately above the arrow. Altitude information is shown at the top of the frame. Here are some examples:



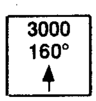
Climb to 4000'



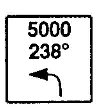
Climbing LEFT turn to 10000'



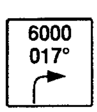
Climbing RIGHT turn to 8000'



Climb to 3000' via heading 160°



Climbing LEFT turn to 5000' to heading 238°

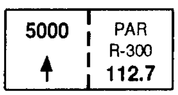


Climbing RIGHT turn to 6000' to heading 017°

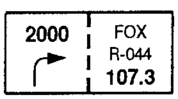
Protocol Form: ***8V page 4 Icon Training***

Crew _______

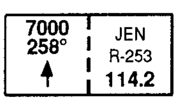
If the procedure requires a climb on a VOR radial, or a climbing turn to intercept a radial, the information is shown in two icon frames. These frames will be separated by a dashed line to indicate that the information in the second (right) frame modifies that in the first (left) frame. The first frame shows direction of flight, heading (if needed) and the specified altitude in the same way as the icons you just reviewed. The second frame shows the name of the VOR, the specified radial and the VOR frequency. Although the text in the following examples mentions "inbound" and "outbound" the icons do not, since this is already depicted on the chart. Please examine the following examples:



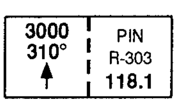
Climb to 5000' outbound via PAR VOR R-300



Climbing RIGHT turn to 2000' outbound via FOX VOR R-044



Climb to 7000' via heading 258° and outbound JEN VOR R-253

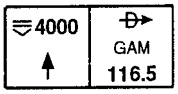


Climb to 3000' via heading 310° and outbound PIN VOR R-303

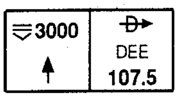
Protocol Form: ***8V page 5 Icon Training***

Crew ______

If the procedure requires that you *climb to* an altitude or *below* (i.e., do not climb higher than the specified altitude), the altitude will be preceded by the symbol, ≡ . If you are required to fly *direct* to a VOR, the VOR information will appear in a second frame, with a solid line separating the two frames, and the symbol Ð► will be shown at the top of the frame to denote direct. The following examples illustrate these rules:

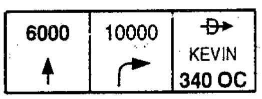


Climb to 4000' or below direct GAM VOR

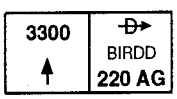


Climb to 3000' or below direct DEE VOR

When the procedure involves an NDB or LOM, both the frequency and the identifier are provided.

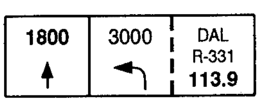


Climb to 6000', then climbing RIGHT turn to 10000' direct KEVIN LOM

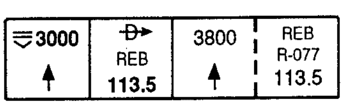


Climb to 3000' direct BIRDD LOM

You may have noticed that some of the text has been bolded. In the following examples, note that the first altitude, the first heading, and the first VOR frequency have been bolded to make them stand out from the rest of the text.



Climb to 1800', then climbing LEFT turn to 3000' inbound via DAL VOR R-331



Climb to 3000' or below direct REB VOR, then climb to 3800' outbound via REB VOR R-077

Protocol Form: ***8V page 6 Icon Training***

Crew ______

Assessment of Prototype Briefing

☐ **Determine readiness of crew to fly with the prototype**

We have gone through the features of the prototype chart, do you have any further questions?

You will be using this prototype in some of the simulator approaches you will be flying in just a few minutes. Do you feel comfortable about using this new prototype?

Would you like to go over some of the features again?

☐ **Turn off the video before going to the simulator**

☐ **Brief simulator operator before crew arrives**

THIS MAY BE DONE BEFORE THE CREW ARRIVES AT THE TRAINING CENTER OR ONE TEAM MEMBER MAY HAVE TO GO TO THE SIMULATOR WHILE THE CREW TAKES A BREAK AFTER THE BRIEFING.

Protocol Form: ***9***

Crew ______

Simulator Operator Instructions

- [ ] Make sure simulator is ready to fly the following approaches:

  - ORD ILS Rwy 14R
  - ORD VOR Rwy 22R

  - DEN ILS/DME1 Rwy 8R
  - DEN NDB Rwy 26L

  - LAX ILS Rwy 24R
  - LAX VOR Rwy 25L/R

- [ ] Examine the schedule to determine the order in which approaches will be flown for this crew

- [ ] Set the ceiling to 200 feet above minimums. Set cloud tops to 10,000 feet if necessary. Set visibility to 1 mile above minimums.

- [ ] Set the initial position for each approach at 5,000 ft AGL on the approach course or at a point on the arrival route for the particular approach which you believe is appropriate for that altitude

- [ ] Release the sim when requested by the study coordinator after the crew has finished briefing the charts

- [ ] Serve as "normal" ATC for the crew

- [ ] For approaches marked as COMPLETE on the schedule, direct the crew to make a "Touch and Go".

- [ ] For approaches marked MISSED and at the altitude shown in bold on the schedule, command the crew to GO AROUND using the published Missed Approach procedure. Terminate the sim once the aircraft is stabilized on the course to the holding point (coordinate with the Pilot Observer).

Protocol Form: *10 page 1*

Crew ______

Simulator Schedule

Order	Seat	Chart	Approach	Type
1	L	S	(1) ORD ILS Rwy 14R	complete
2	R	S	(2) DEN ILS/DME1 Rwy 8R	complete
3	L	P	(3) LAX ILS Rwy 24R	MISSED **320'** (200')
4	R	P	(4) ORD VOR Rwy 22R	complete
5	L	P	(5) DEN NDB Rwy 26L	complete
6	R	P	(6) LAX VOR Rwy 25L/R	MISSED **1800'** (1699')
7	L	P	(1) ORD ILS Rwy 14R	MISSED **1800'** (1133')
8	R	P	(2) DEN ILS/DME1 Rwy 8R	complete
9	L	S	(3) LAX ILS Rwy 24R	MISSED **1800'** (1680')
10	R	S	(4) ORD VOR Rwy 22R	MISSED **1040'** (388')

Protocol Form: ***10 page 2 Typical Schedule***

Crew ______

Simulator Procedures

❑ **Determine if crew is a line crew (captain and first officer) or an "instructor" crew (two captains, check airmen, training captains, etc.)**

FOR THE PURPOSES OF THIS STUDY, A "LINE" CREW CONSISTS OF ONE PILOT WHO NORMALLY FLIES FROM THE LEFT SEAT AND ONE WHO NORMALLY FLIES FROM THE RIGHT SEAT.

AN "INSTRUCTOR" CREW IS ANY COMBINATION OF TYPES OF PILOTS WHO EITHER FLY REGULARLY FROM THE LEFT SEAT OR DO NOT CURRENTLY FLY THE LINE AT ALL, E.G., PROFESSIONAL INSTRUCTORS.

❑ **Select LINE or INSTRUCTOR versions of schedule as appropriate**

BOTH LINE AND INSTRUCTOR VERSIONS ARE INCLUDED TO ACCOMMODATE EITHER TYPE OF CREW.

❑ **Distribute copies of simulator schedule to each experimenter and the simulator operator**

MAKE SURE THAT THE CREW NUMBER ON THE SCHEDULE IS CORRECT

THE INSTRUCTORS WILL ALWAYS FLY THE APPROACHES FROM THE LEFT SEAT: ONE PILOT WILL FLY ALL 5 OF HIS/HERS SCHEDULED APPROACHES, THEN THE SECOND PILOT WILL TAKE THE LEFT SEAT AND FLY HIS/HERS.

THE LINE CREWS WILL FLY THE FIRST APPROACH FROM THE LEFT SEAT AND THEN ALTERNATE BETWEEN RIGHT AND LEFT SEATS.

THE MISSED APPROACHES INDICATED IN THESE SCHEDULES ARE THE ONES THAT WILL BE CALLED BY THE SIMULATOR OPERATOR. IT IS ALSO POSSIBLE THAT A CREW WILL INITIATE A GO AROUND IF THEY FEEL THAT THEY ARE NOT PROPERLY ALIGNED, OR NOT AT THE APPROPRIATE SPEED TO COMPLETE THE APPROACH. WE WILL CONTINUE OUR SCHEDULE AS SHOWN AND ADD THE CREW-INITIATED MISSED APPROACH TO THE SCHEDULED ONES FOR DATA ANALYSIS. THE RESEARCH TEAM MUST BE ALERT TO RECORD THE FACT OF A CREW-INITIATED GO AROUND SO THAT WE CAN DISCUSS THE REASONS FOR THE GO AROUND FOR POSSIBLE INSIGHTS ABOUT CHART FEATURES.

Protocol Form: ***11 page 1***

Crew ______

Each scheduled missed approach will be called at one of two altitudes: just before the aircraft reaches the Minimum Descent Altitude (MDA); and the altitude which is about midway between the Final Approach Fix (FAF) and the MDA. These altitudes are referred to respectively as "Low" and "Mid" and will be distributed as follows:

Line Crews: Approaches 3 and 10 will be **Low**
Approaches 6, 7, and 9 will be **Mid**

Instructor Crews: Approaches 2 and 5 will be **Low**
Approaches 4, 8, and 10 will be **Mid**

❑ **Describe procedure**

We will be flying 10 approaches to various airports. We will freeze the sim at 5,000 feet AGL on the final approach course. We will then give you an approach chart and an airport diagram and indicate which of you is to fly the approach. You can then take as much time as needed to brief the approach. When you are ready, let us know and we will release the sim. After the approach is finished, we will discuss it briefly while the simulator is being reset. Please brief and fly in accordance with your company's normal procedures. You can configure the aircraft in any mode you desire, but please let us know what mode you have selected.

IF THIS IS AN ODD NUMBER CREW (BRIEFED WITH 8V), ADD:

When flying with the prototype, please make every attempt to use the icons to brief the approach and to fly any missed approach. If you need to refresh your memory on the meaning of the icons, please do so by reading the text version in the BRIEFING STRIP while the simulator is frozen.

ON APPROACHES TO TOUCHDOWN, THE SIMULATION CAN BE ENDED AT APPROXIMATELY 40 KTS. ON MISSED APPROACHES, THE SIMULATION SHOULD BE CONTINUED UNTIL THE AIRCRAFT IS STABLE ON THE OUTBOUND RADIAL TO THE HOLDING POINT.

❑ **Label tape with crew number, load tape in simulator video and turn it on (if available)**

Protocol Form: ***11 page 2***

Crew ______

Pilot-Observer Simulator Data Collection

☐ **Record your rating of BRIEFING COMPLETENESS on the Pilot-Observer Data Collection Form**

USE A SCALE OF 0 TO 6 TO INDICATE THE NUMBER OF BRIEFING ELEMENTS THAT WERE NOT COVERED.

☐ **Record your rating of BRIEFING CONFIDENCE on the Pilot-Observer Data Collection Form**

USE A SCALE OF GOOD (G), FAIR (F) AND POOR (P) TO INDICATE HOW ASSURED THE CREW WAS ABOUT THE APPROACH INFORMATION DURING THE BRIEFING.

☐ **Record your rating of APPROACH EXECUTION on the Pilot-Observer Data Collection Form**

USE A SCALE OF GOOD (G), FAIR (F) AND POOR (P) TO INDICATE HOW WELL THE CREW FLEW THE APPROACH. IF A MISSED APPROACH IS BEGUN, RECORD HERE YOUR RATING FOR THE PERIOD UP TO THE DECISION TO GO AROUND.

☐ **Record your rating of MISSED APPROACH EXECUTION on the Pilot-Observer Data Collection Form**

USE A SCALE OF GOOD (G), FAIR (F) AND POOR (P) TO INDICATE HOW WELL THE CREW FLEW THE MISSED APPROACH.

☐ **Record whether or not the crew re-briefed missed approach information after the decision to go around**

CHECK "Y" IF THEY RE-BRIEFED OR "N" IF THEY DID NOT.

☐ **Record whether or not the crew used the autothrottle for the approach**

CHECK "Y" IF THEY USED THE AUTOTHROTTLE OR "N" IF THEY DID NOT. IF THE AIRCRAFT DOES NOT HAVE AN AUTOTHROTTLE, NOTE THIS ONCE IN THE COMMENTS.

☐ **Record the flying method used by the crew**

CHECK "HAND" FOR A MANUALLY FLOWN APPROACH USING THE YOKE OR SIDESTICK (WITH OR WITHOUT FLIGHT DIRECTOR INFORMATION). CHECK "MCP" FOR AN APPROACH FLOWN THROUGH THE MODE CONTROL PANEL OR FLIGHT CONTROL UNIT. CHECK "AUTO" FOR AN AUTOMATIC APPROACH.

Protocol Form: ***12 page 1***

Crew ______

Pilot-Observer Data Collection Form

Approach Number	Observation of		Observation of		Re-brief during M/A?		Auto-Throttle		Flying Method		
	Briefing Completeness (# Missed)	Briefing Confidence	Approach Execution	M/A Execution	Y	N	Y	N	Hand	MCP	Auto
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

COMMENTS: (Reference by approach number)

Protocol Form: ***12 page 2***

Crew _______

Human Factors Observer Simulator Data Collection

- ☐ **Record the start and end times of the crew approach briefings while the simulator is frozen**

- ☐ **Record comments on the briefing, approach execution and missed approach execution as appropriate in the spaces provided**

- ☐ **If the crew re-briefs during a missed approach, record the contents of the re-briefing in the "Missed Approach Comment" column**

THIS CHECKLIST PRESUMES THAT THE OBSERVER WILL MONITOR THE VOICE COMMUNICATIONS IN THE COCKPIT AND THAT HE WILL HAVE REASONABLY GOOD VISUAL ACCESS TO THE CREW. THE HUMAN FACTORS ISSUES--SPEED AND ACCURACY OF PERFORMANCE--WILL NOT BE DIRECTLY OBSERVABLE, EXCEPT FOR THE TIME REQUIRED TO COMPLETE THE APPROACH BRIEFING WHICH WE WILL MEASURE AND RECORD. WE CAN, HOWEVER, INFER SOME THINGS ABOUT THE FEATURES OF THE CHART BEING USED FROM OUR OBSERVATIONS. THERE SEEM TO BE THREE THINGS THAT MIGHT REASONABLY BE INFERRED FROM OUR OBSERVATIONS AND MONITORING:

- LEGIBILITY--AN ENCOMPASSING CHARACTERISTIC, BUT ONE WE CAN INFER FROM EVIDENCES OF <u>POOR</u> LEGIBILITY SUCH AS BRINGING THE CHART CLOSER TO THE EYES OR MOVING IT TO BETTER LIGHTING. ALSO, ANY COMMENT BY THE CREW ABOUT LEGIBILITY SHOULD BE NOTED.

- ARRANGEMENT (OR ORGANIZATION) OF THE CHART--CLUES OF <u>POOR</u> ARRANGEMENT WOULD BE USING A FINGER TO "TRACK" THE INFORMATION, MOVING THE ORIENTATION OF THE CHART FROM A USUAL READING POSITION, AND OBVIOUS SEARCHING. AGAIN, ANY VERBALIZED PROBLEM, OR A DISCUSSION AMONG THE CREW SHOULD BE NOTED

- INTERPRETABILITY--THIS REALLY CANNOT BE DIRECTLY OBSERVED, BUT SIGNS OF DIFFICULTY IN INTERPRETATION INCLUDE A NOTICEABLY LONG TIME TO BRIEF SOME PART OF THE APPROACH OR TO RESPOND TO A QUESTION FROM THE OTHER CREW MEMBER. VERBALIZATION OF A PROBLEM, OR SPECIFIC QUESTIONS SHOULD BE NOTED.

THE CHECKLIST PROVIDES SPACE FOR THE OBSERVER TO RECORD HIS ASSESSMENT OF THE CHART IN EACH OF THE APPROACH FUNCTIONS (BRIEFING, APPROACH EXECUTION AND MISSED APPROACH EXECUTION). IN ADDITION THE OBSERVER WILL NOTE AS MANY SPECIFIC EVENTS AS POSSIBLE SO THAT THE COMPLETED CHECKLIST CAN BE USED AS A GUIDE TO VIEWING THE VIDEO TAPE. THE OBSERVER'S NOTES AND THE TAPE OF THE EVENT SHOULD PROVIDE ADEQUATE EVIDENCE TO SUPPORT THE ASSESSMENT.

Protocol Form: ***13 page 1***

Crew _______

AS SHOWN ON THE NEXT PAGE, THE CHECKLIST SIMPLY PROVIDES SPACE FOR THE RECORD OF THE OBSERVER, INCLUDING THE START AND END TIMES OF THE APPROACH BRIEFING WHILE THE SIMULATOR IS FROZEN, I.E., THE INTERVAL BETWEEN THE TIME THAT THE CREW IS HANDED THE CHARTS FOR AN APPROACH AND THE TIME THAT THE SIMULATOR IS RELEASED TO THEM. INCLUDE IN THE BRIEFING ANY TIME FOR FMS PROGRAMMING.

Protocol Form: ***13 page 2***

Crew ______

Human Factors Observer Simulator Data Collection

Approach Number	Start/End	Briefing Comment	Approach Execution Comment	Missed Approach Comment
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Protocol Form: *13 page 3*

Crew ______

Simulator Session Debrief

- ☐ **Label a new tape. Place it in the camcorder. Turn the video on again**

- ☐ **Pass out answer sheet for flown prototype**

USE EITHER ANSWER SHEET 14V OR 14J FOR THE VOLPE (ODD NUMBER CREWS) AND JEPPESEN (EVEN NUMBER CREWS) PROTOTYPES, RESPECTIVELY.

- ☐ **Describe process of questionnaire data collection**

I will now read you some statements about the design of the prototype chart with which you have just flown. For each statement, I would like you to indicate on a scale of 1 to 6 whether the prototype was significantly worse or significantly better than the current Jeppesen-type design. The scale is shown on the top of the answer sheet I just gave you. After I read each statement, all you have to do is place an "X" in the box which corresponds with your answer for the statement number we are working on. Please answer independently.

- ☐ **Read each statement, point to the feature on the large chart, wait for a score to be recorded and then discuss and reconcile the answers of the two pilots**

READ EITHER QUESTION LIST 14V OR 14J FOR THE VOLPE (ODD NUMBER CREWS) AND JEPPESEN (EVEN NUMBER CREWS) PROTOTYPES, RESPECTIVELY. THE QUESTION NUMBERS ARE KEYED TO THE ANNOTATED CHART AT THE END OF THIS EXPLANATION.

IT IS CRITICAL TO DETERMINE THE REASON FOR EACH PILOT'S RATING AFTER EACH QUESTION IS POSED

- ☐ **Collect the answer sheets**

- ☐ **Brief the crew on the second prototype**

BRIEF THE VOLPE (FORM 8V) FOR ODD NUMBERED CREWS OR THE JEPPESEN (FORM 8J) FOR EVEN NUMBERED CREWS.

- ☐ **Pass out answer sheet for second prototype**

USE EITHER ANSWER SHEET 14V OR 14J FOR THE VOLPE (ODD NUMBER CREWS) AND JEPPESEN (EVEN NUMBER CREWS) PROTOTYPES, RESPECTIVELY.

Protocol Form: ***14 page 1***

Crew _______

- [ ] **Indicate that the same process of questionnaire data collection will be used**

  We're now going to use the same scale to respond to some statements about this second prototype.

- [ ] **Read each statement, wait for a score to be recorded and then discuss and reconcile the answers of the two pilots**

READ EITHER QUESTION LIST 14V OR 14J FOR THE VOLPE (ODD NUMBER CREWS) AND JEPPESEN (EVEN NUMBER CREWS) PROTOTYPES, RESPECTIVELY.

IT IS CRITICAL TO DETERMINE THE REASON FOR EACH PILOT'S RATING AFTER EACH QUESTION IS POSED

- [ ] **Collect the answer sheets**

Protocol Form: ***14 page 2***

Crew ______

Question List for "J" Prototype

☐ **Read the following questions verbatim. Point to the feature as you ask the question.**

Compared to the current Jeppesen-type chart, how much better or worse does each of the following features make the prototype?

1. The information needed to brief the approach or for use in setting up the flight management system has been reformatted in the Heading area of the chart.

2. The four letter ICAO identifier is included in the Heading of the chart.

3. The frequency and call sign of the primary navaid are presented in large, boldfaced type.

4. The chart index number is shown in large, boldfaced type.

5. Communications information is arranged vertically and boxed in the order in which the services are used during an approach.

6. Communications frequencies are shown in boldfaced type.

7. All named approach fixes are shown in bold on one side of the approach course.

8. The MSA origin point is shown as a symbol in the MSA circle with the identification shown in bold adjacent to the circle.

9. MSA sectors are depicted as radial outbound from the origin.

10. All obstacles outside 1 mile from the approach course have been deleted from the map view.

11. The Final Approach Course and related information is shown in large type.

    DISCUSS THE DISPLAY OF THE COURSE WHICH IS SHOWN IN LARGE SCALE AND THE LARGE, BOLD TYPE USED FOR THE MARKERS AND INTERSECTIONS.

Protocol Form: ***14J page 1***

12. Procedural and equipment notes are contained in the Notes Box on the map view near the Approach Course Heading.

    DISCUSS THE CONTENTS OF THE NOTES BOX.

13. The navigation elements of the missed approach procedure have been bolded.

14. The name of the Missed Approach fix is shown in large, boldfaced type on the map.

15. Minimum altitudes in the Profile and Minimums Sections are shown in bold type.

16. The airport is highlighted with a shaded circle.

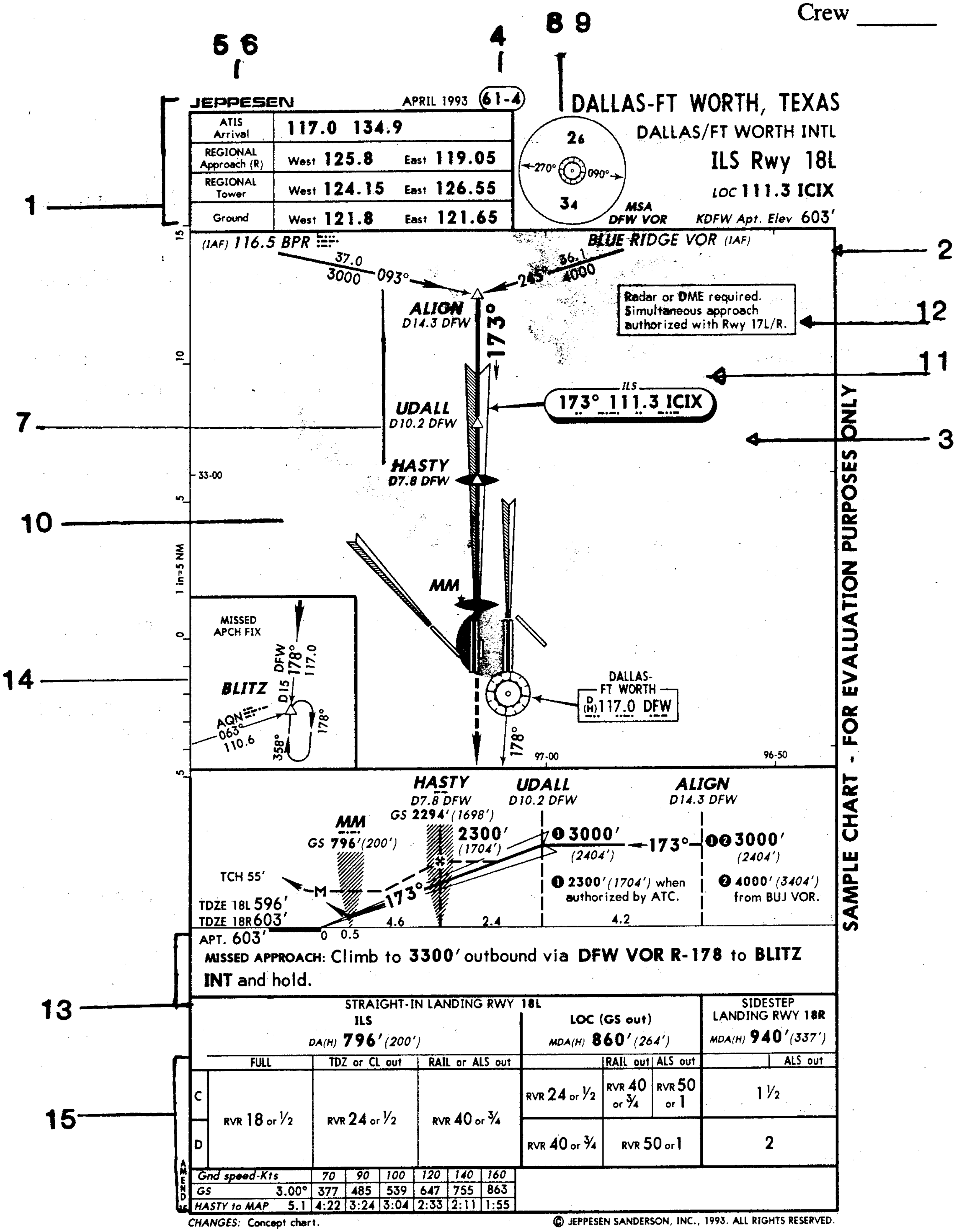
Crew _______

Responses to Statements About Prototype Design

Statement Number	Significantly Worse 1	2	3	4	5	Significantly Better 6
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

Protocol Form: *14J page 3*

Crew ______



Protocol Form: *14J page 4*
(Chart keyed to questions on 14J pages 1 and 2)

Crew ______

Question List for "V" Prototype

☐ **Read the following questions verbatim. Point to the feature as you ask the question.**

Compared to the current Jeppesen-type chart, how much better or worse does each of the following features make the prototype?

1. The information needed to program a flight management computer or to use for quick reference in case of a last minute change in runways is contained in the top row of the Briefing Strip.

2. For non-precision approaches to either of two runways, both TDZEs are shown and both are in bold type. SHOW LA VOR 25L/R CHART

3. The communications frequencies are boxed and aligned horizontally in the second row of the Briefing Strip in the order in which they are used.

   DISCUSS WHETHER THE HORIZONTAL FORMAT OF THE FREQUENCIES IS PREFERRED TO THE CURRENT VERTICAL FORMAT.

   DISCUSS WHETHER THE USE OF NUMERALS WHICH ARE SLIGHTLY SMALLER THAN THOSE IN THE TOP ROW WAS NOTICED AT ALL AND, IF SO, WHETHER IT WAS A PROBLEM.

4. The consolidation of notes, approach lighting, missed approach text and airport elevation in the third row of the briefing strip.

   DISCUSS NOTES, APPROACH LIGHTING, MISSED APPROACH TEXT AND AIRPORT ELEVATION SEPARATELY.

   DISCUSS IF FONT SIZE IS ADEQUATE FOR THIS INFORMATION.

5. The identification of the referenced navaid for the MSA by its call sign in the center of the circle.

6. The use of radials rather than bearings to define the sectors of the MSA.

7. The use of sectional chart notation for the altitudes in the MSA.

8. The use of a box around the approach course in the Plan View.

Protocol Form: ***14V page 1***

9. The depiction of only those obstacles and airports within 5 miles of the approach course in the Plan View.

DISCUSS THE REMOVAL OF THE OTHER OBSTACLES AND AIRPORTS SEPARATELY.

10. The depiction of the controlling obstacle in the Plan View even if it is outside 5 miles.

BE SURE THAT THEY UNDERSTAND THAT THE HIGHEST (CONTROLLING) OBSTACLE IS STILL SHOWN BUT ONLY IF IT FALLS WITHIN THE NORMAL SCALE OF THE MAP.

11. The deletion of the middle marker information from the Plan View while leaving it in the Profile View.

12. The deletion of the Morse Code for the primary navaid from the Plan View.

13. The depiction of the "up and out" missed approach maneuvers by icons in the Profile View.

DISCUSS THE USE OF ICONS IN GENERAL AS WELL AS ONLY SHOWING "UP AND OUT."

DISCUSS THE USE OF LARGER TYPE AND BOLDING FOR THE FIRST ALTITUDE AND NAVAID WITHIN THE ICONS (SEE 3300 AND 117.0 ON THE LARGE DFW CHART). DO THEY PREFER THE FREQUENCY OR THE RADIAL BOLD OR BOTH?

14. The depiction of the TDZE for the intended runway in bold type.

15. The use of bold type in the Minimums area for the decision altitudes for straight-in landings to the intended runways.

DISCUSS THE FACT THAT OTHER, LESS USED MINIMA ARE NOT BOLDED.

16. Do you need circle-to-land minimums on charts for Part 121 operations? (circle yes or no)

17. IF YES TO 16, SHOW THE SIDE-BY-SIDE ORD VOR 22R CHARTS (STANDARD AND V-PROTOTYPE) AND ASK:

Do you prefer the prototype format? (circle yes or no)

Crew ______

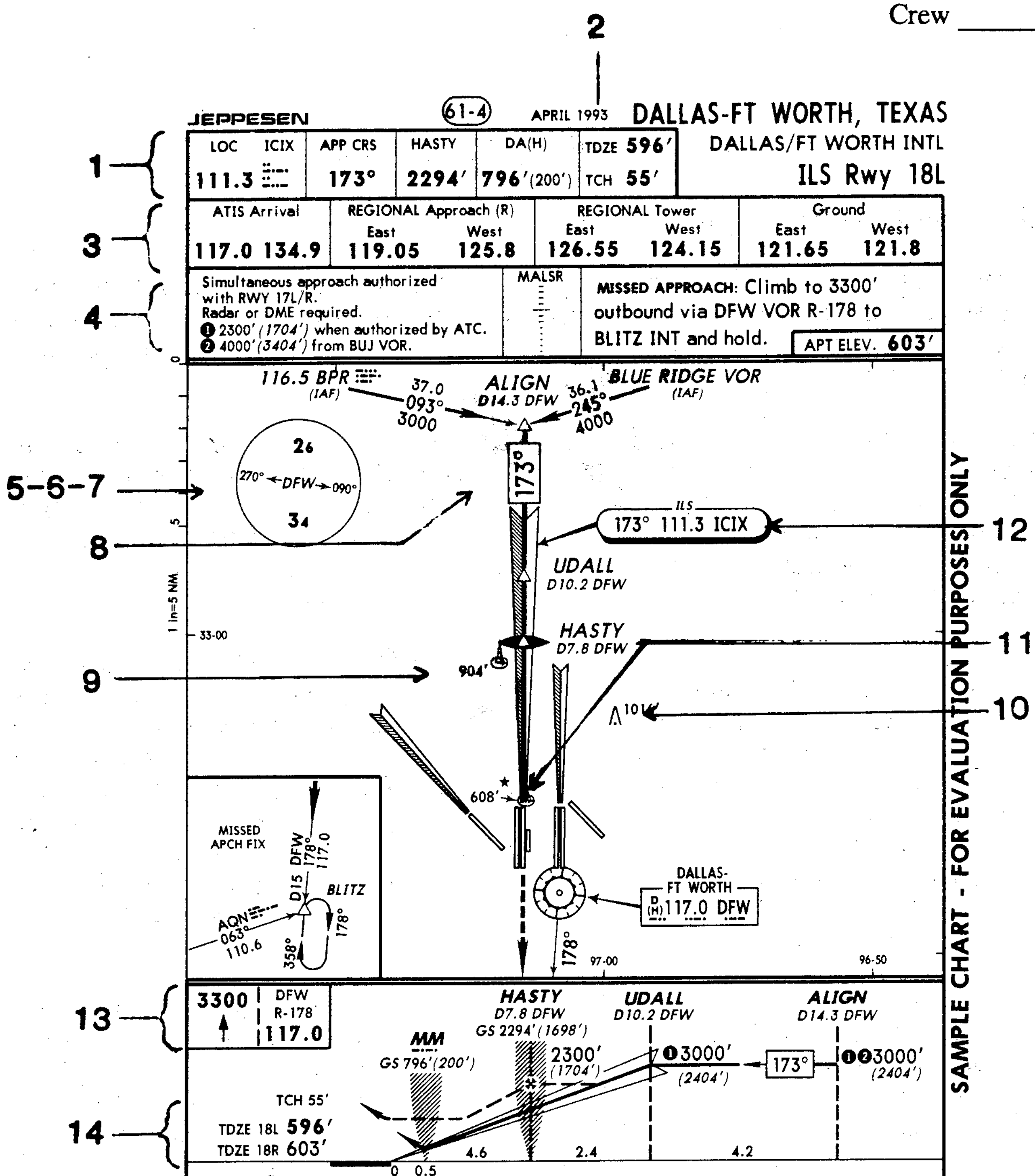
Responses to Statements About Prototype Design

Statement Number	Significantly Worse 1	2	3	4	5	Significantly Better 6
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

16		Yes	No
17	(if Yes to 16)	Yes	No

Protocol Form: *14V page 3*

Crew ______



STRAIGHT-IN LANDING RWY 18L						SIDESTEP LANDING RWY 18R
ILS DA(H) 796'(200')				LOC (GS out) MDA(H) 860'(264')		MDA(H) 940'(337')
	FULL	TDZ or CL out	RAIL or ALS out		RAIL out / ALS out	ALS out
C	RVR 18 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 24 or ½	RVR 40 or ¾ / RVR 50 or 1	1½
D	RVR 18 or ½	RVR 24 or ½	RVR 40 or ¾	RVR 40 or ¾	RVR 50 or 1	2

Gnd speed-Kts	120	140	160
GS 3.00°	647	755	863
HASTY to MAP 5.1	2:33	2:11	1:55

AMEND 15

CHANGES: Concept chart.

Protocol Form: *14V page 4*
(Chart keyed to questions on 14V pages 1 and 2)

Crew ______

Direct Scaling Comparison

☐ **Explain the direct scaling process**

THIS PART OF THE STUDY IS ESSENTIALLY A SUMMARY EVALUATION. EACH OF THE CREWS WILL HAVE HAD SOME EXPERIENCE WITH BOTH PROTOTYPES AND WILL HAVE FLOWN APPROACHES WITH AT LEAST ONE OF THE PROTOTYPES AND WITH THE STANDARD. NOW THEY WILL GIVE AN OVERALL EVALUATION.

THE DIRECTIONS EMPHASIZE THAT CREW MEMBERS WILL MAKE THEIR JUDGEMENTS INDEPENDENTLY THEY ALSO WILL BE ENCOURAGED TO RELY ON THEIR FIRST REACTIONS, BUT WILL BE GIVEN AS MUCH TIME AS THEY NEED TO ARRIVE AT A JUDGMENT. THEY WILL BE ASKED TO INDICATE THEIR JUDGMENT BY PLACING A REPLICA OF EACH CHART ON A SCALE OF ACCEPTABILITY WHERE 1 REPRESENTS LEAST ACCEPTABLE AND 100 MOST ACCEPTABLE. THE RESEARCH TEAM WILL RECORD THE POSITIONS.

We will now ask you for a relative evaluation of the three IAP charts that have been used in this study. You each have a scale on the table in front of you. That scale is numbered from 0 to 100 where 0 denotes least acceptable and 100, most acceptable for air carrier operations. I will give you a set of three approach plate reproductions (one of each of those used in this study). On each reproduction, a pointer has been drawn beneath the plate. Your task will be to place each plate on the scale with its pointer aligned to the position on the scale that reflects your opinion of the acceptability of that plate for your use in making an air carrier approach to an unfamiliar airport. You will be asked to make three separate scalings one for: Briefing the Approach, Executing the Approach, and Executing a Missed Approach.

These reproductions show the DFW approach as a reminder of what each chart looks like. However, we do not want you to evaluate this particular approach. We want you to think about using a chart with the same features, but at an unfamiliar airport. Please make your decision on the basis of your experience with these charts in this study. Obviously, you have had only limited experience with each prototype chart today. Try to think about how you would feel about each prototype design after you have had time to become completely familiar with it.

You might think that some features of each chart are quite useful and some others are not. For this evaluation, however, please make your decision about each chart based on how it appears now. We can talk about the different features at the end of this session.

Protocol Form: ***15 page 1***

There are no rules about how to use the scale other than higher numbers indicate a "better" chart design. ***First place the chart you think is best. Then place the other two relative to the first.*** *You may place these charts at any point on the scale. If you think that two or all of them are the same, position them to the same mark on the scale. If you think that the charts are very close, position them overlapping so that the arrow points to the mark you have selected.*

Remember, you will be asked to make 3 scaled judgements: Briefing, Approach Execution, and Missed Approach Execution. Try to keep each function separate in your mind and decide about them separately. The charts do not have to be judged the same for each function.

- ☐ **Ask for scale response for BRIEFING AN APPROACH. Record the three values on the data collection form (15-3)**
- ☐ **Ask for scale response for EXECUTING AN APPROACH TO TOUCHDOWN AND ROLLOUT. Record the three values on the data collection form (15-3)**
- ☐ **Ask for scale response for EXECUTING A MISSED APPROACH. Record the three values on the data collection form (15-3)**
- ☐ **Ask them each to hand the team the one chart design that they would buy if they could only have one and they were all the same price.**

Assume that you must recommend to your line which one of the three approach charts that we have used today should be purchased. The purchase is for the entire fleet, and the services, such as updating, will be the same for each of the charts. The price of the charts and the service is the same for all three charts. Remember that the purchase is for the entire fleet so the charts will be used by crews at all levels of experience, and on all of the aircraft that your line operates. Your decision may or may not be the same as your personal evaluations that you made earlier today.

Crew ______

Direct Scaling Values

CREW ______A				CREW _____B			
Chart Type	Function			Chart Type	Function		
	Brief	Execute	Miss		Brief	Execute	Miss
Green (Std)				Green (Std)			
Red (V)				Red (V)			
Blue (J)				Blue (J)			

Circle the chart type of the one handed to you as the selected "buy" for each pilot.

Protocol Form: *15 page 3*

Crew ______

"Decision to Buy" Evaluation

☐ **Explain the "Crew-oriented" evaluation approach**

THE PURPOSE OF THIS EVALUATION EXERCISE IS TO HAVE THE CREW ASSUME THE RESPONSIBILITY OF PURCHASING ONE DESIGN OF APPROACH CHARTS FOR THEIR COMPANY. WE WANT TO RECORD THE PROCESS BY WHICH THE CREW ARRIVES AT THEIR DECISION AND THEREBY GAIN SOME INSIGHT ABOUT WHAT IS IMPORTANT IN EVALUATING APPROACH CHARTS FOR "ACTUAL" USE. THE OTHER EVALUATION PROCEDURES USED IN THIS STUDY, ALL RELATE TO THE CREW'S ATTITUDE TOWARD APPROACH PLATES AND TO THEIR EXPERIENCE IN THE SIMULATOR, FLYING A FEW APPROACHES. THIS ROLE-PLAYING MAY REVEAL DIFFERENT INFORMATION ABOUT HOW APPROACH PLATES ARE JUDGED FOR OVERALL UTILITY TO AN AIRLINE.

THE FOLLOWING SCRIPT SETS THE STAGE FOR THE EVALUATION, AND INCLUDES THE FEW RULES THAT THE CREW MUST FOLLOW. SO FAR AS POSSIBLE THE RESEARCH TEAM SHOULD NOT BECOME INVOLVED IN THE PROCESS ONCE THE SCRIPT HAS BEEN COMPLETED. IF THE CREW HANGS UP, HOWEVER, AND IS UNABLE TO CONTINUE THE PROCESS, THE TEAM CAN STEP IN AND HELP THEM GET STARTED AGAIN. OTHERWISE IT SHOULD BE LEFT TO THE CREW TO GO THROUGH THE DECISION PROCESS.

☐ **If they agreed on which chart to buy, discuss their reasons**

You both agreed that you would buy (   ) chart design. Please discuss your reasons with each other while we listen.

☐ **If they disagreed on which chart to buy, role play as shown below**

We want you to reconcile the decisions you just made regarding which chart design you would buy. Assume that you share the responsibility for recommending to your line which one of these three approach charts should be purchased. You must reach a joint decision for one and only one chart design.

As you go through the decision process, will you please talk your way through so that we will have a record of how you made up your minds. If you find that you have differences of opinion, please work them out by talking your way through and arrive at a single recommendation. The Research Team will not take part in this process, except to listen to it.

Protocol Form: ***16 page 1***

Crew ______

☐ Listen to the decision-making and record any notes about the discussion below

Record the crew's decision

Current Jeppesen ______

Volpe Prototype ______

Jeppesen Prototype ______

Protocol Form: ***16 page 2***

Crew ______

Additional Simulator Time

- ☐ **If additional simulator time is available, return to the simulator**

- ☐ **Fly as many approaches as time permits with the prototype which was not flown previously**

FOLLOW THE PREVIOUS PROTOCOL OR REQUESTS FROM THE CREW TO RE-FLY CERTAIN ASPECTS OF THE STUDY

- ☐ **Record all data on additional copies of Forms 12 and 13**

Protocol Form: 17

Crew ______

End of Session

- ☐ Thank the crew and offer them a summary of the study. Get their names and addresses for mailing the summary and record below

- ☐ Turn off the video, label the tape and remove the record protect tab

Protocol Form: *18*

APPENDIX B

Copies of the Current Standard and Prototype IAP Charts for the Six Different Approaches Flown During the Simulator Sessions

Charts Included in Appendix B

- Chicago O'Hare International (ORD) ILS Runway 14R
- Chicago O'Hare International (ORD) VOR Runway 22R
- Denver Stapleton International (DEN) ILS DME-1 Runway 8R
- Denver Stapleton International (DEN) NDB Runway 26L
- Los Angeles International (LAX) ILS Runway 24R
- Los Angeles International (LAX) VOR Runway 25L/R

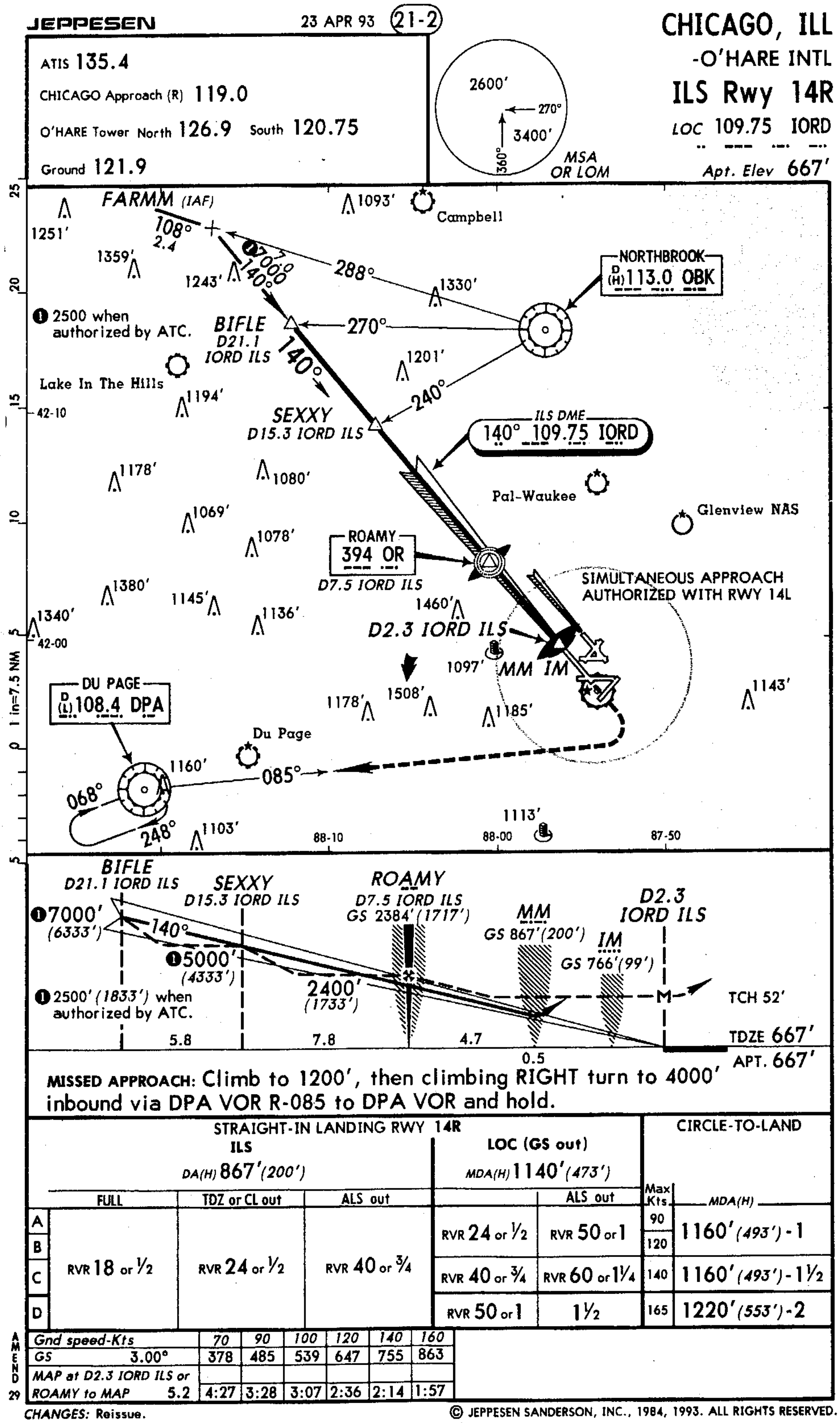


Figure B-1. Current Standard IAP Chart for Chicago O'Hare International (ORD) ILS Runway 14R

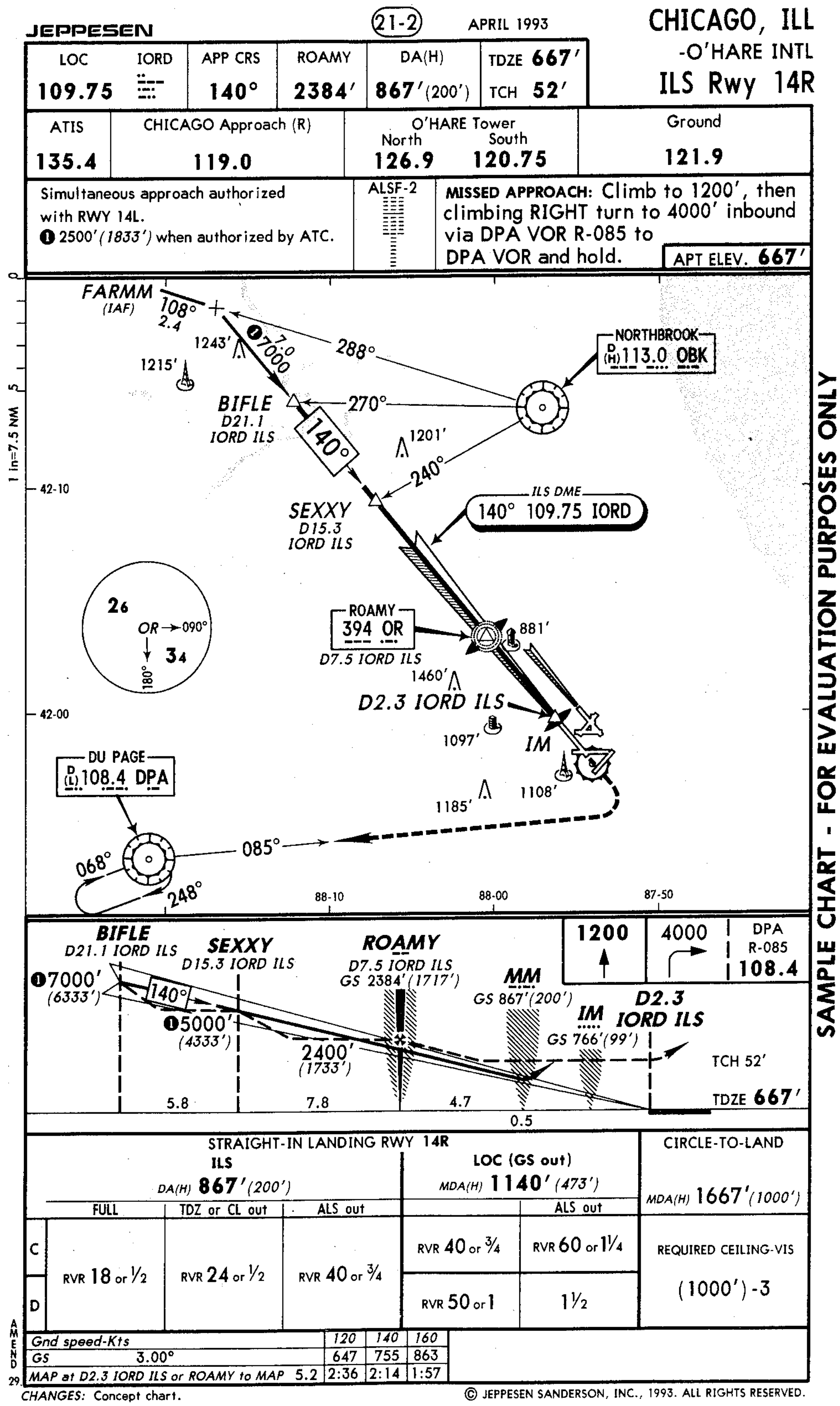


Figure B-2. Volpe/ATA Prototype IAP Chart for Chicago O'Hare International (ORD) ILS Runway 14R

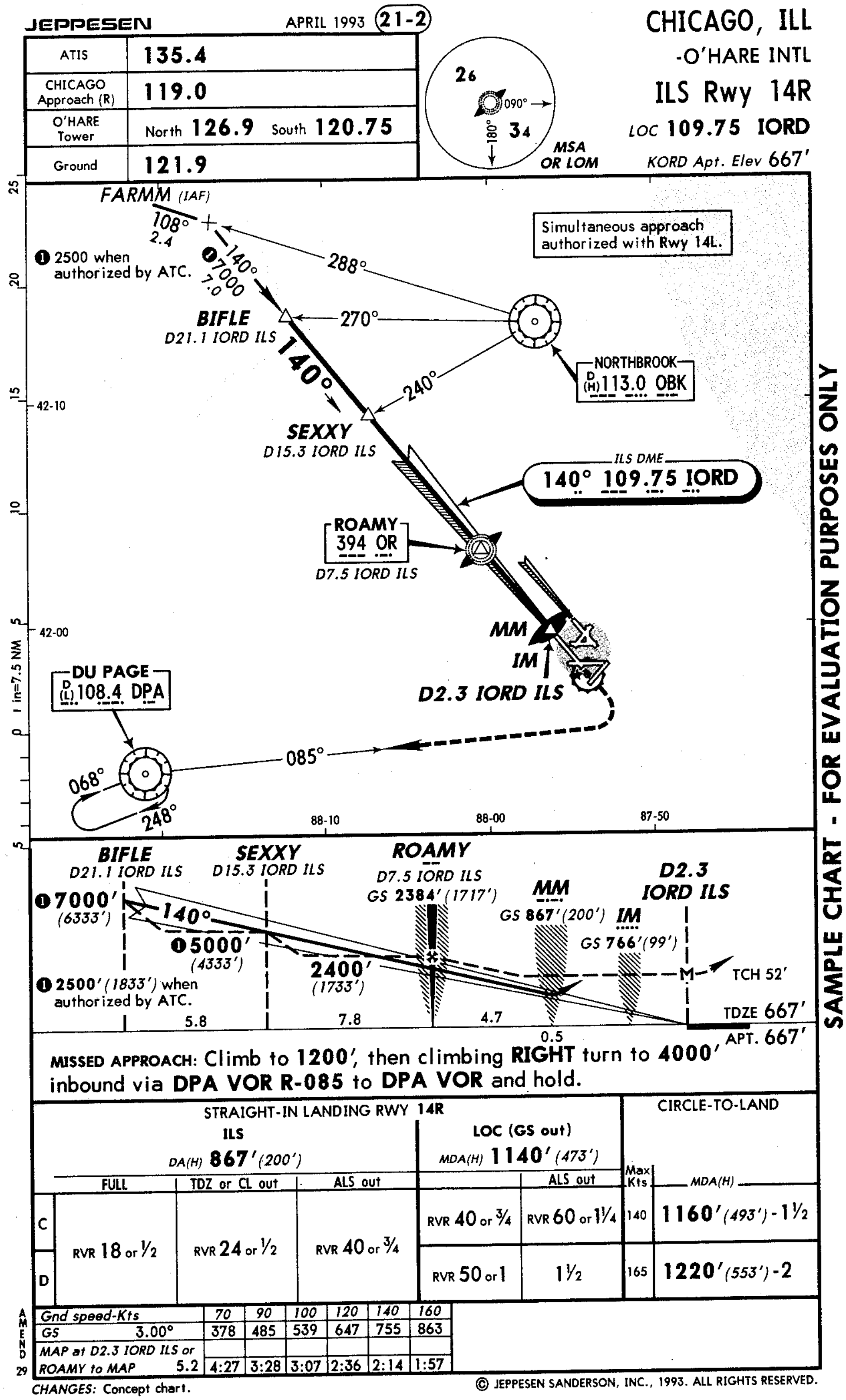


Figure B-3. Jeppesen Prototype IAP Chart for Chicago O'Hare International (ORD) ILS Runway 14R

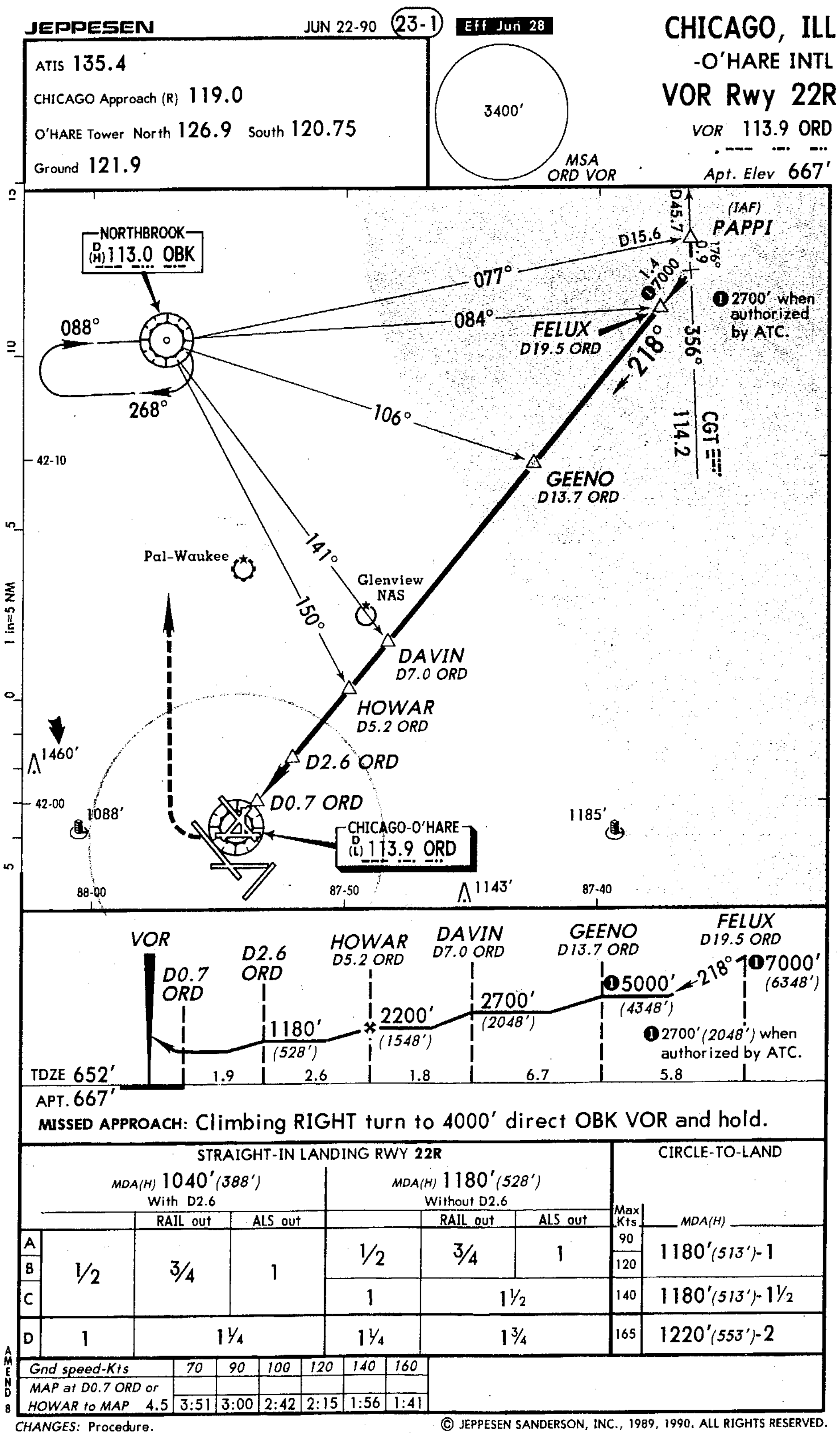


Figure B-4. Current Standard IAP Chart for Chicago O'Hare International (ORD) VOR Runway 22R

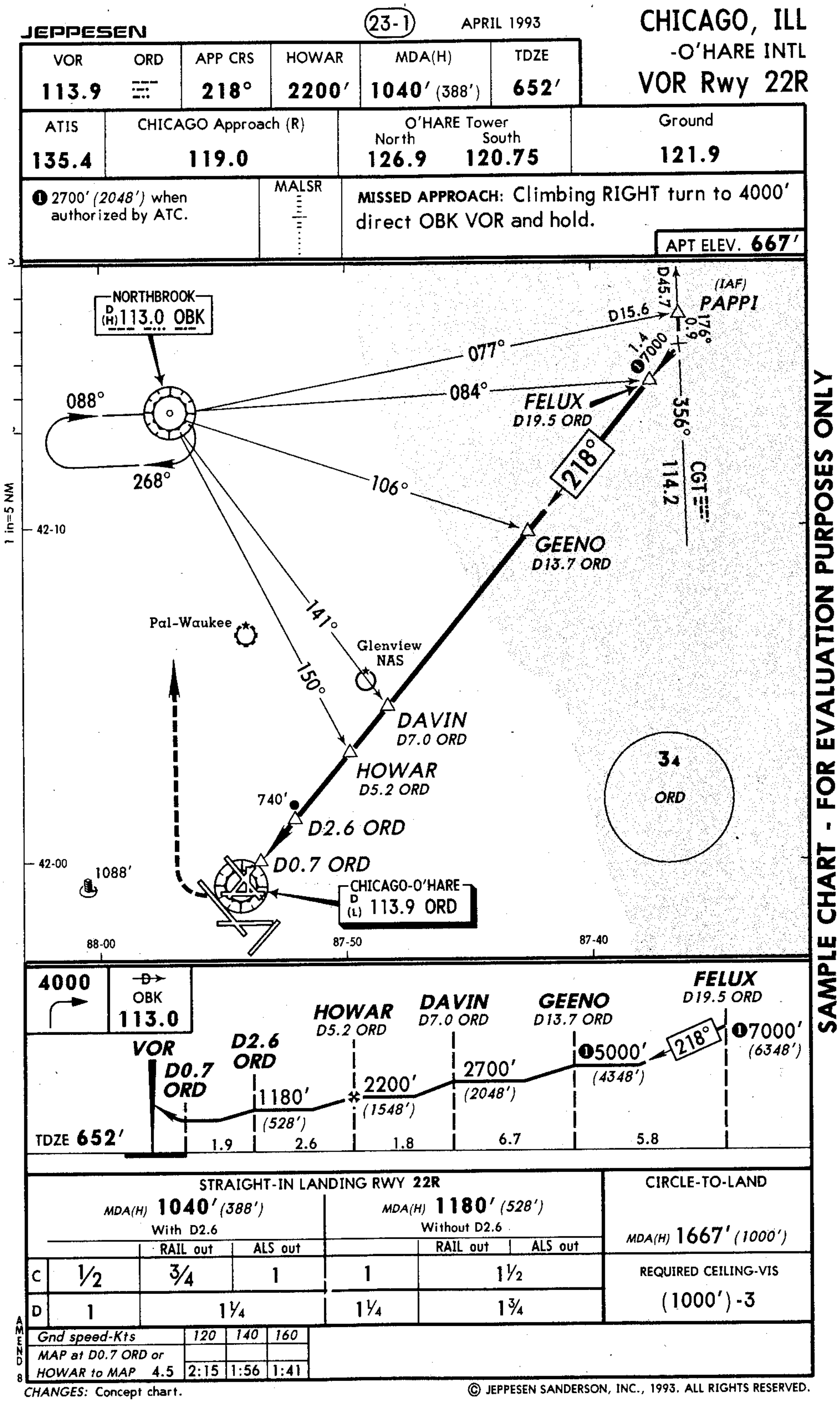


Figure B-5. Volpe/ATA Prototype IAP Chart for Chicago O'Hare International (ORD) VOR Runway 22R

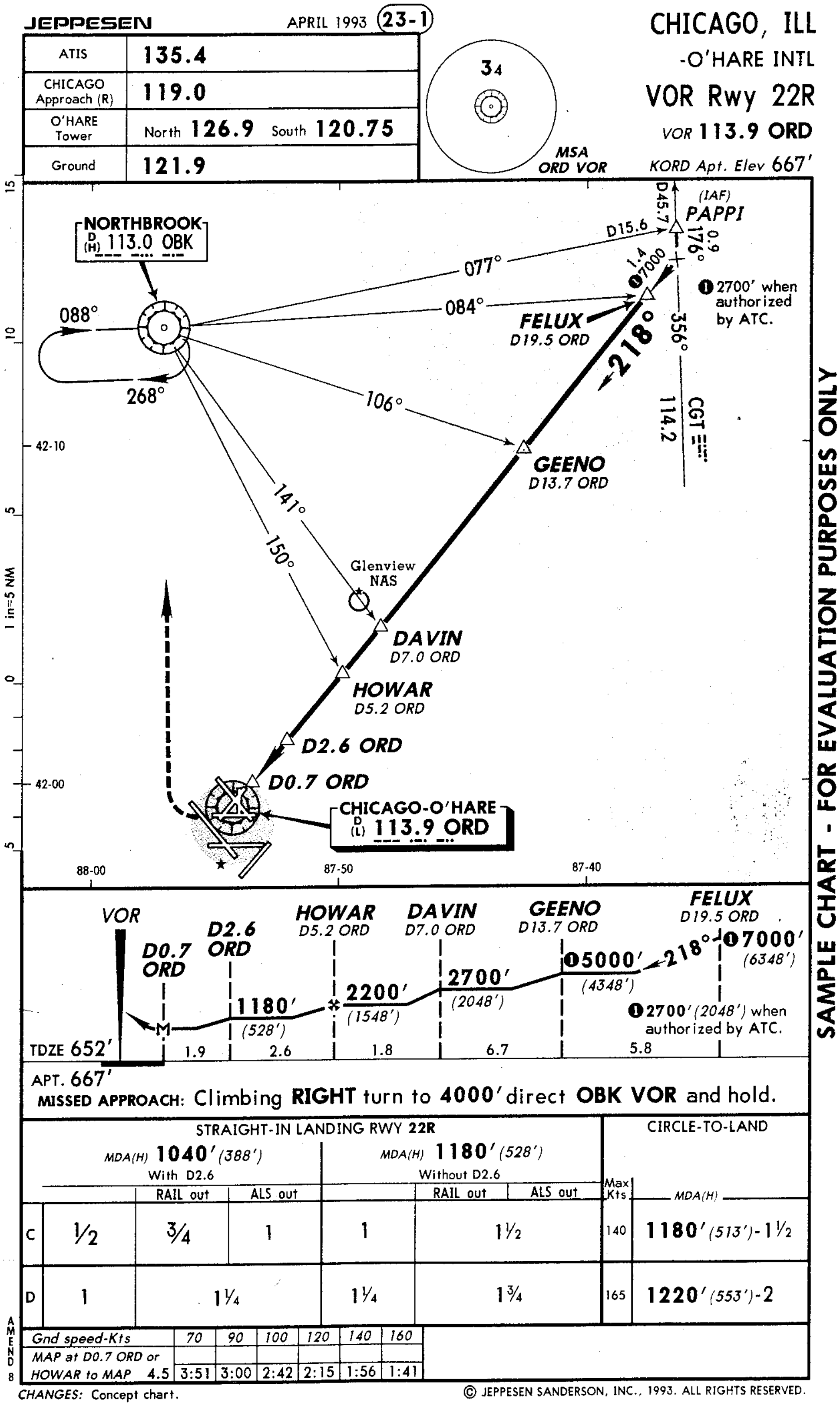


Figure B-6. Jeppesen Prototype IAP Chart for Chicago O'Hare International (ORD) VOR Runway 22R

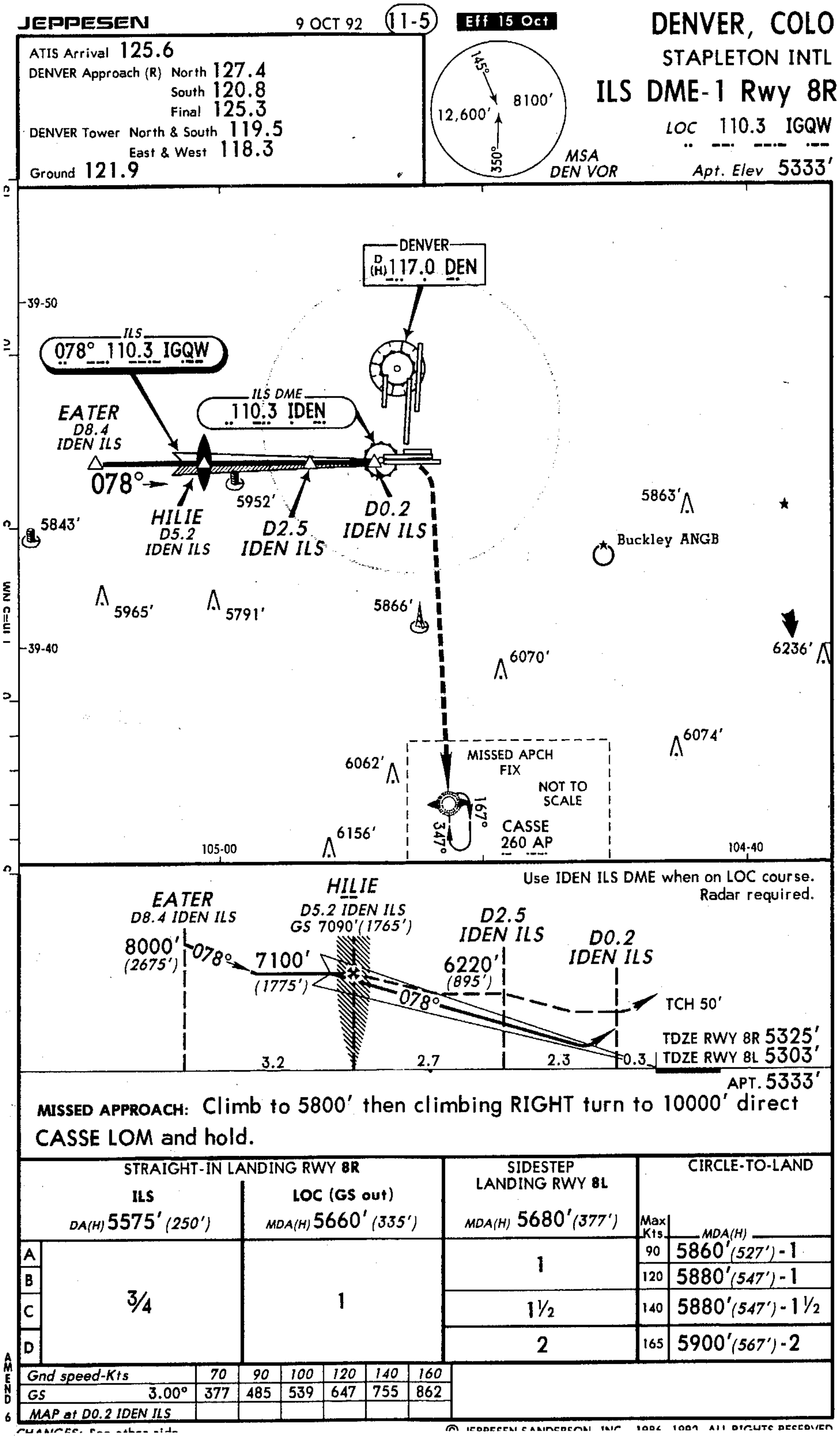


Figure B-7. Current Standard IAP Chart for Denver Stapleton International (DEN) ILS DME-1 Runway 8R

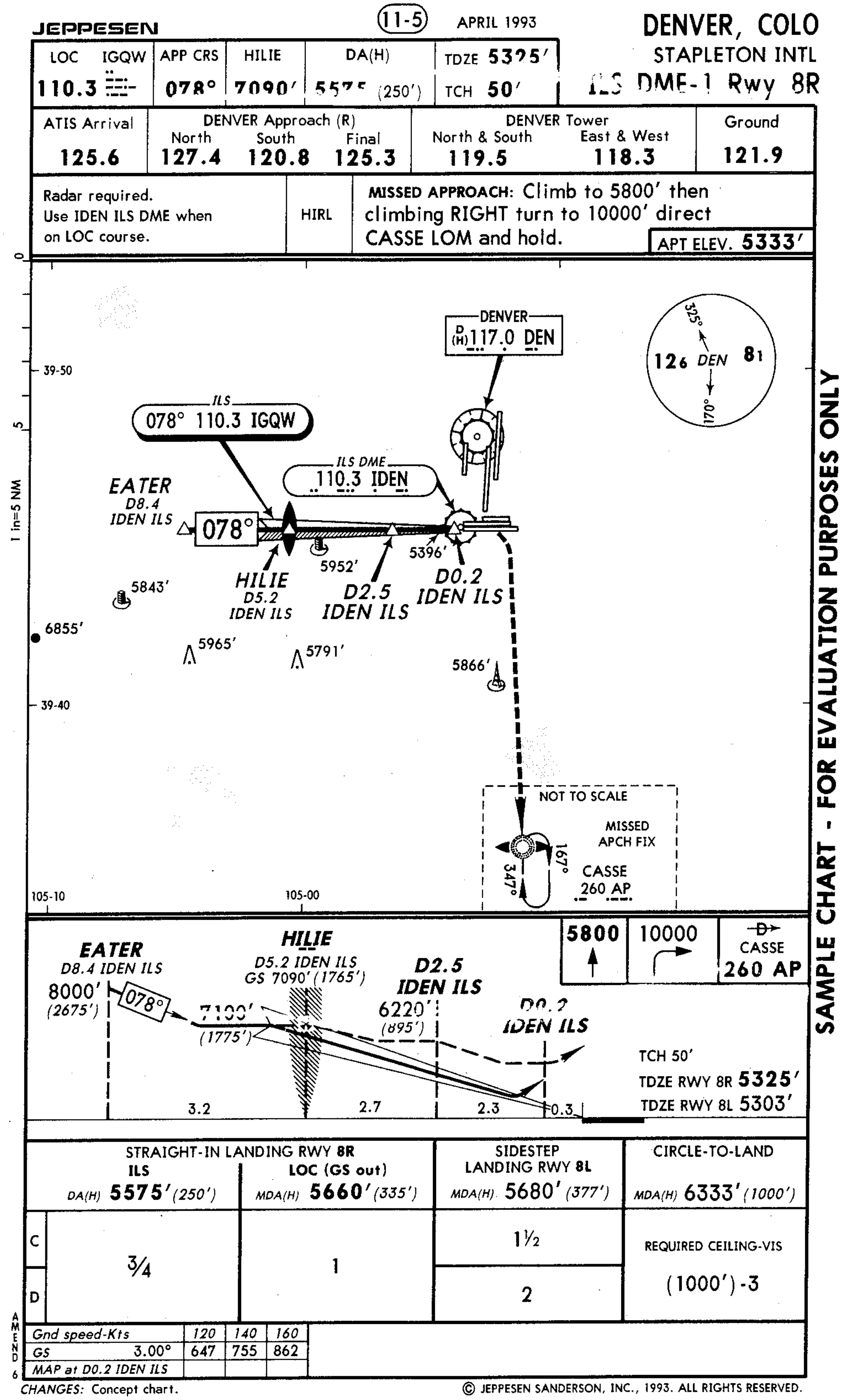


Figure B-8. Volpe/ATA Prototype IAP Chart for Denver Stapleton International (DEN) ILS DME-1 Runway 8R

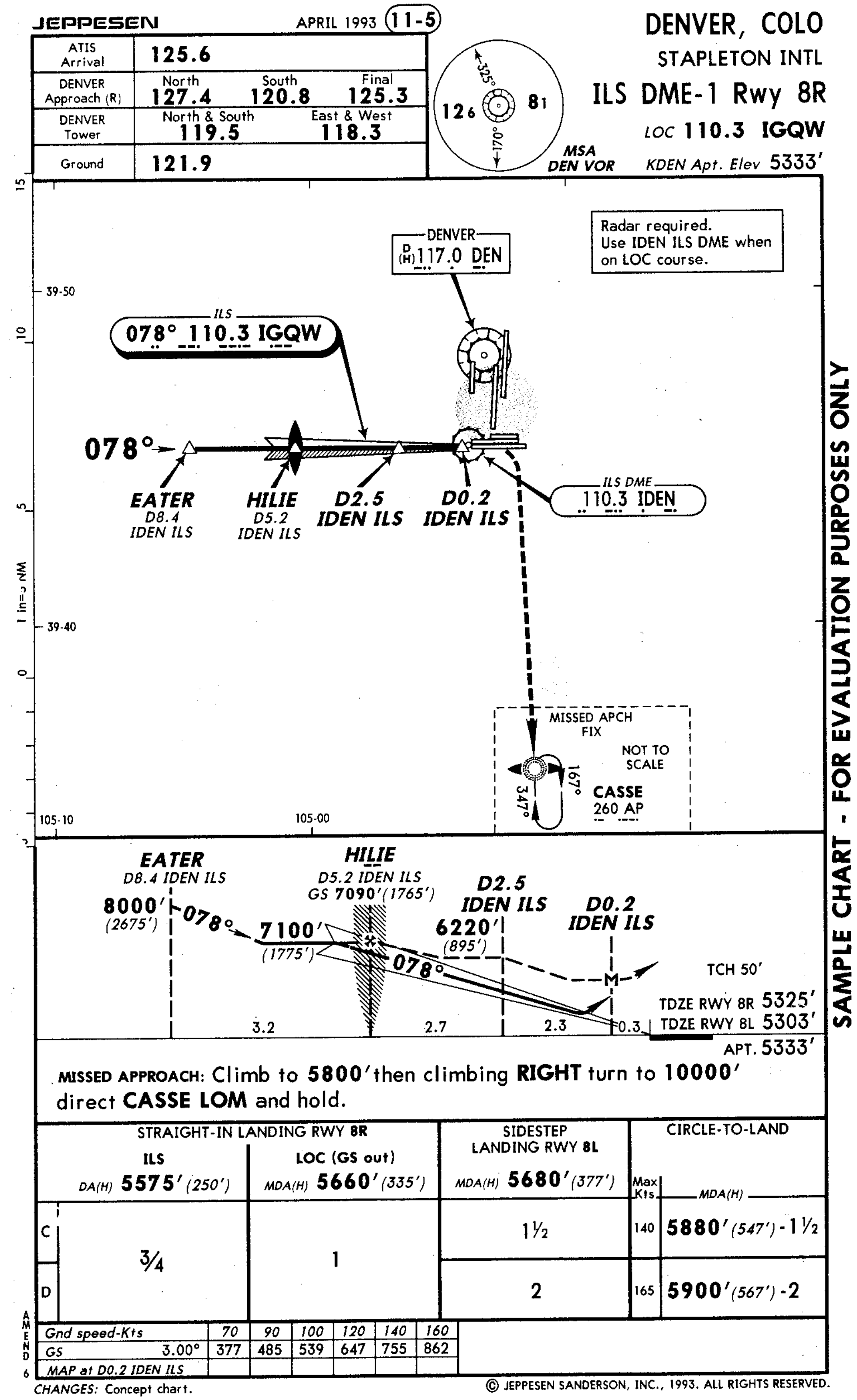


Figure B-9. Jeppesen Prototype IAP Chart for Denver Stapleton International (DEN) ILS DME-1 Runway 8R

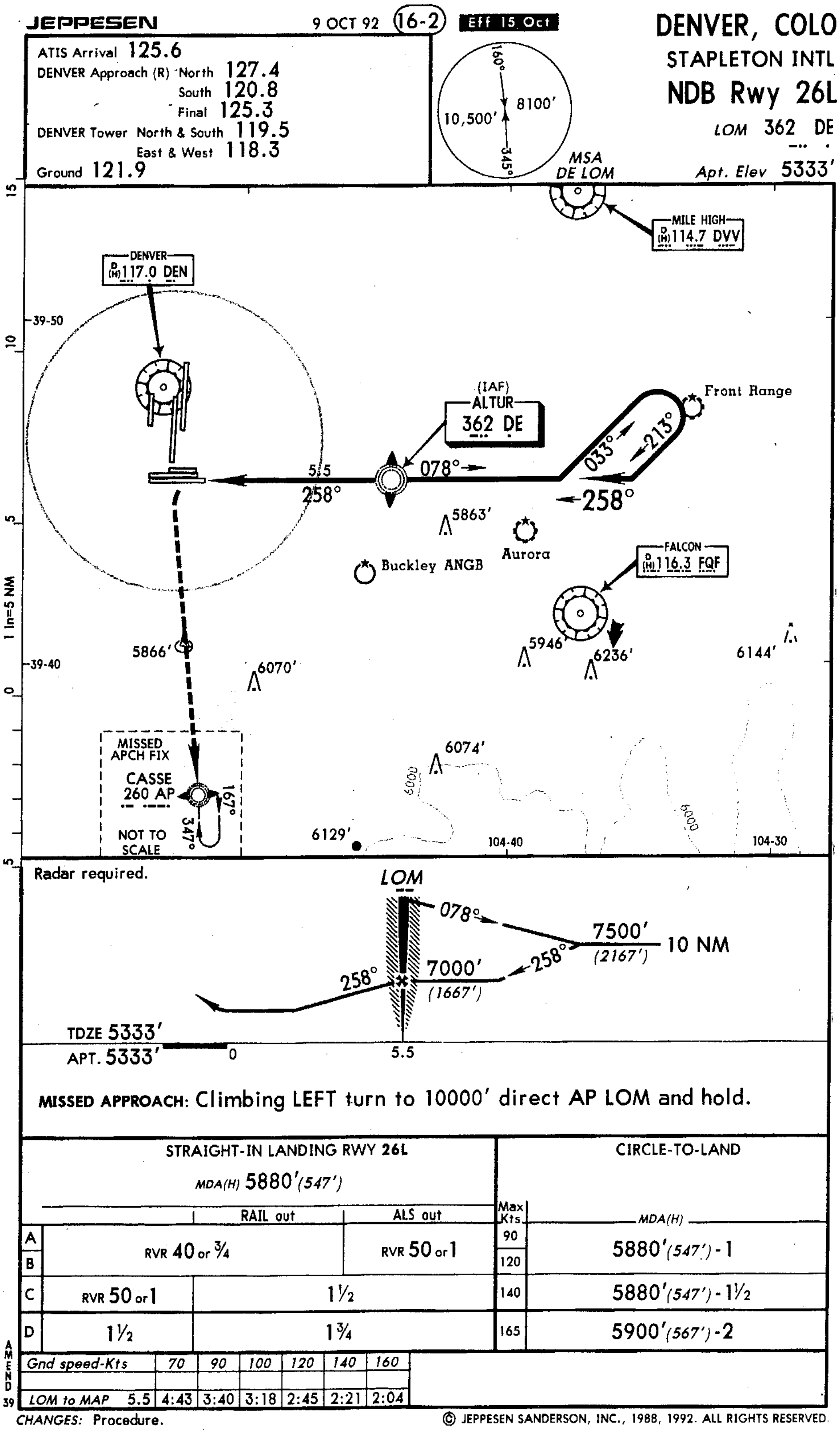


Figure B-10. Current Standard IAP Chart for Denver Stapleton International (DEN) NDB Runway 26L

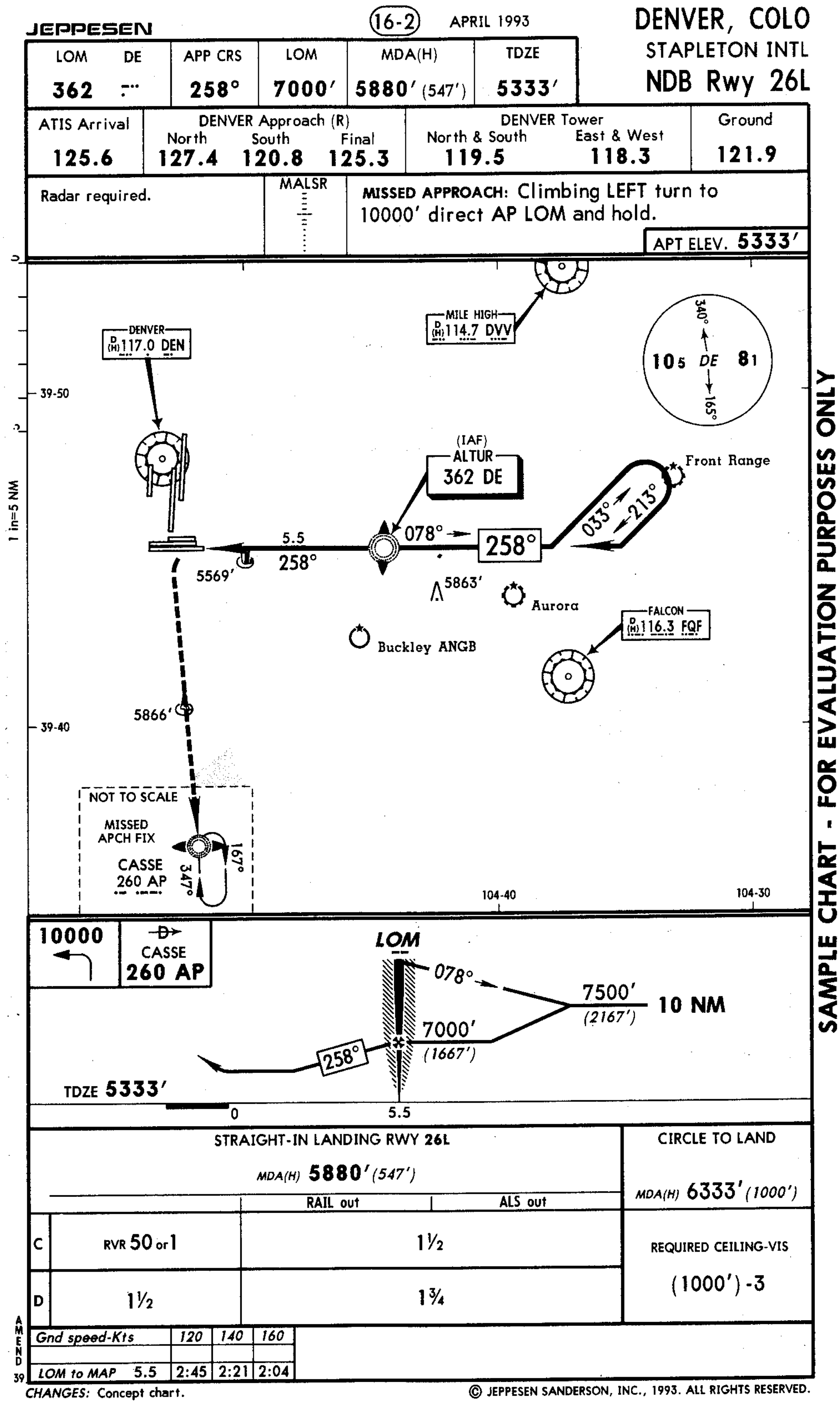


Figure B-11. Volpe/ATA Prototype IAP Chart for Denver Stapleton International (DEN) NDB Runway 26L

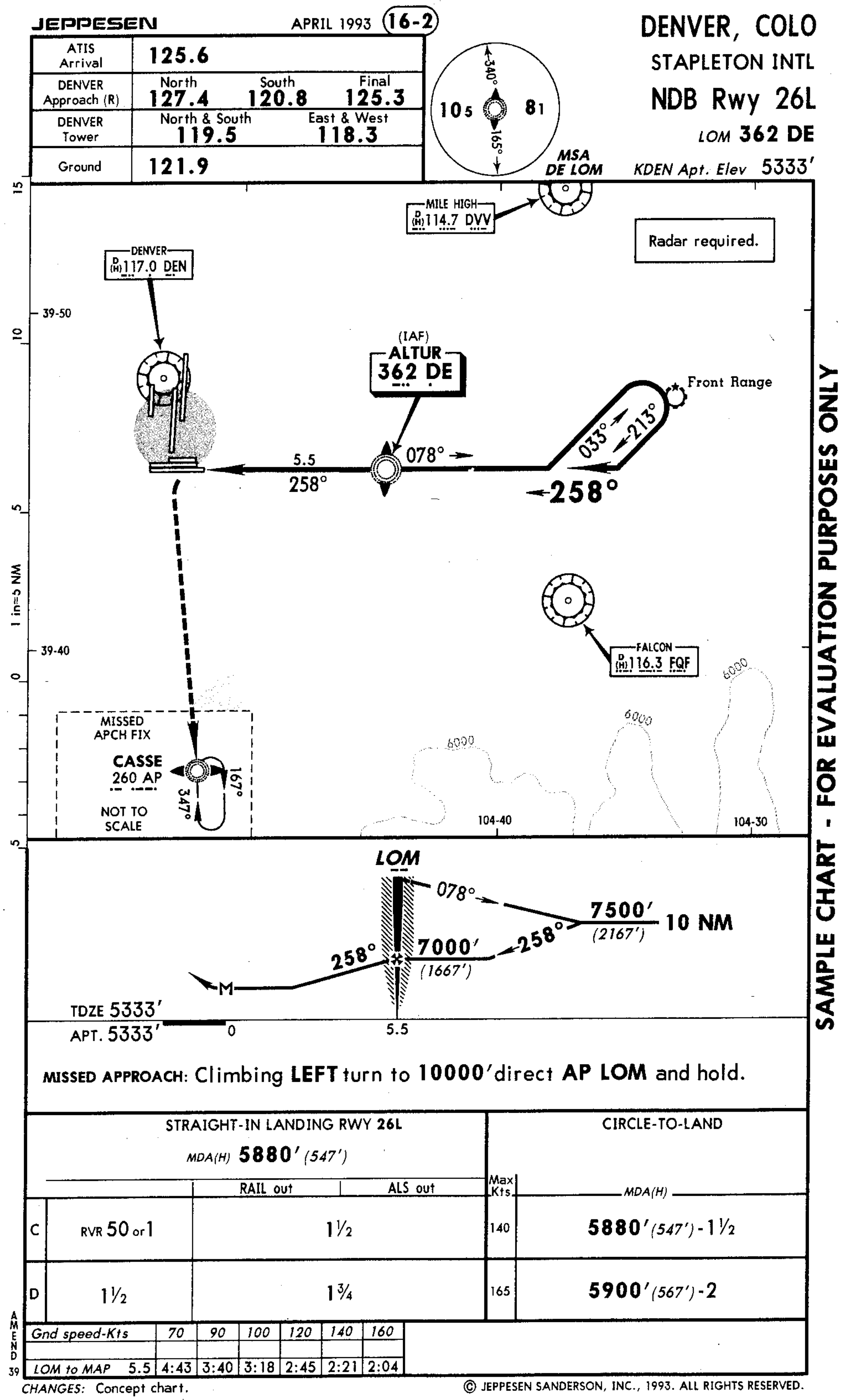


Figure B-12. Jeppesen Prototype IAP Chart for Denver Stapleton International (DEN) NDB Runway 26L

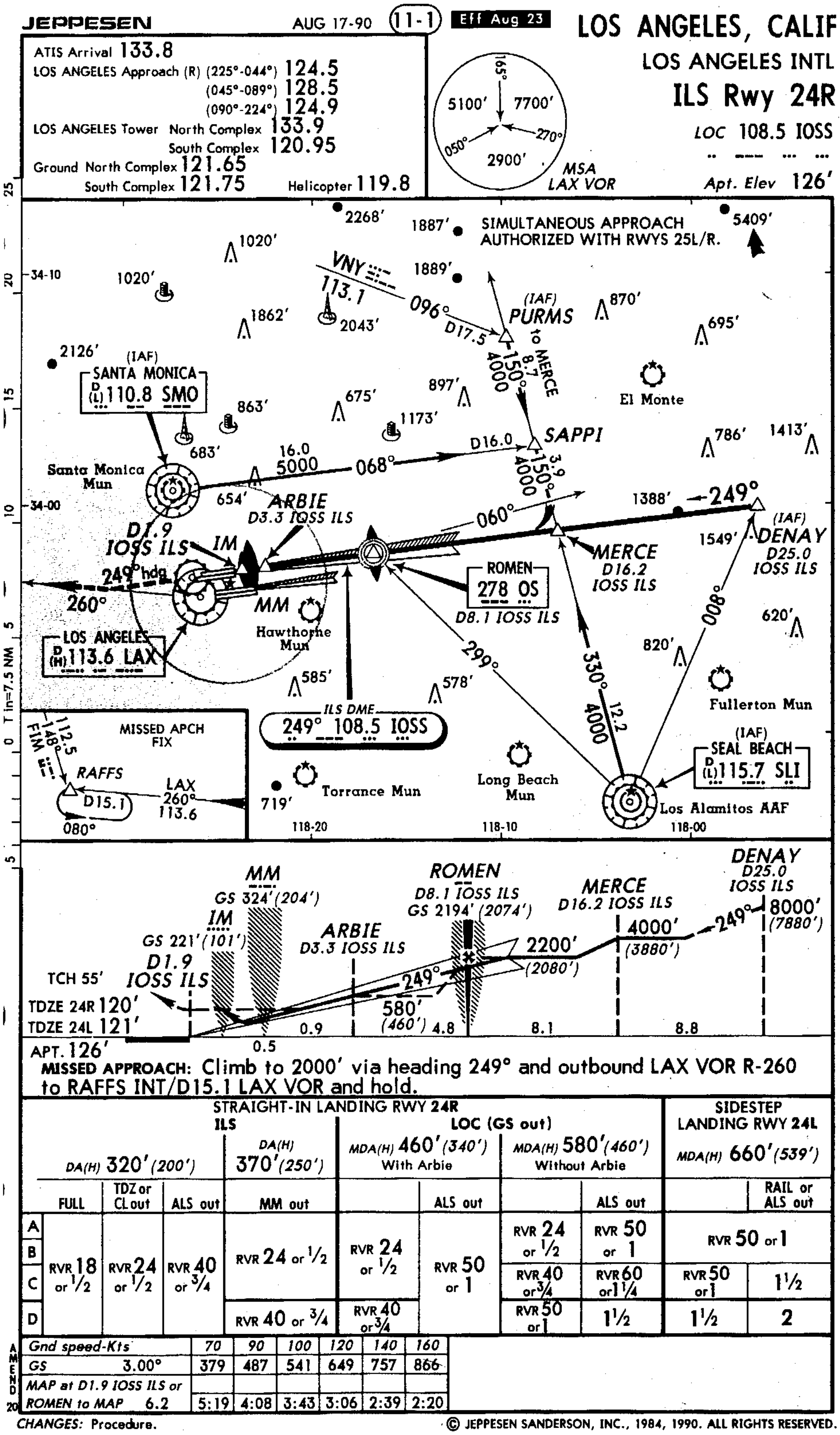


Figure B-13. Current Standard IAP Chart for Los Angeles International (LAX) ILS Runway 24R

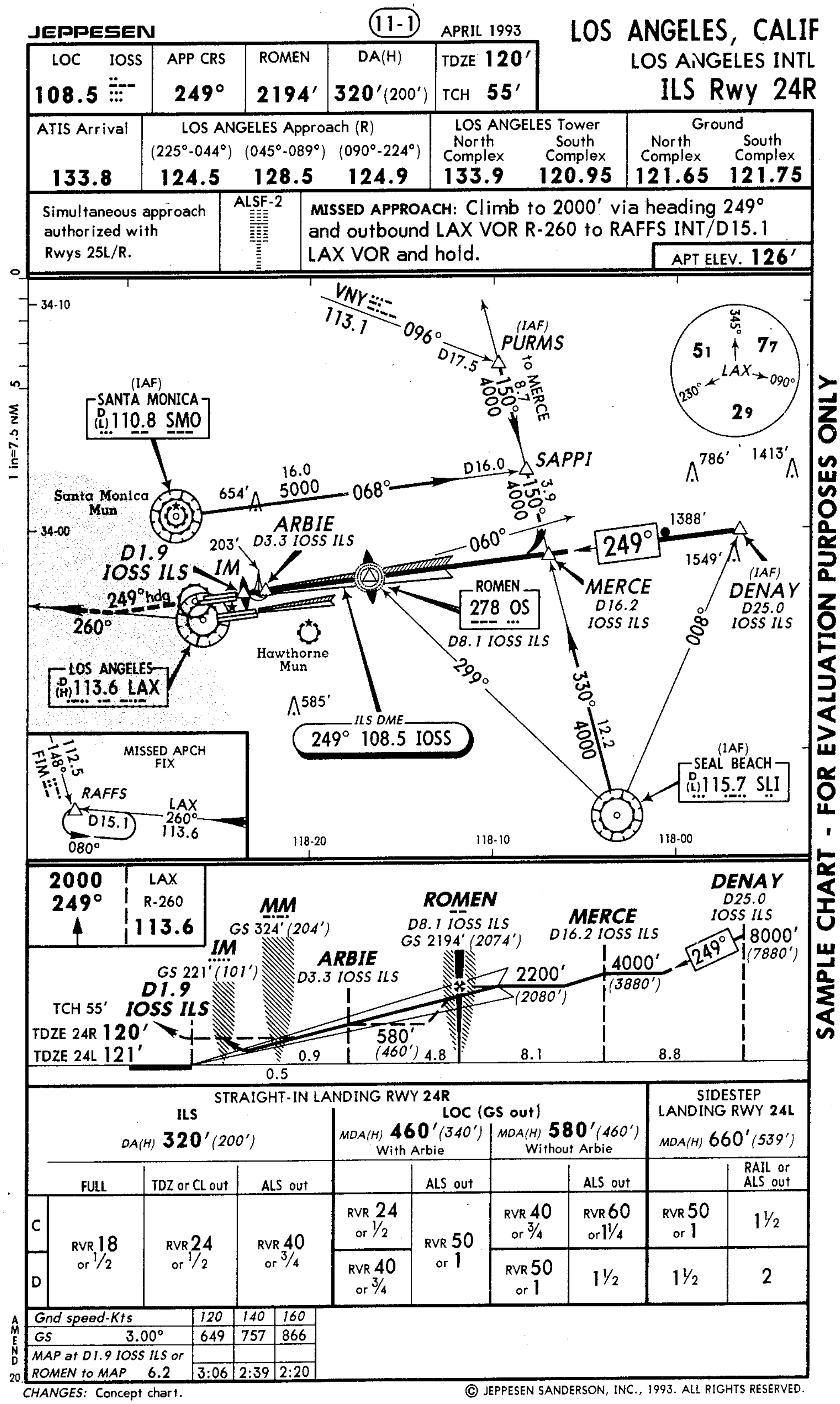
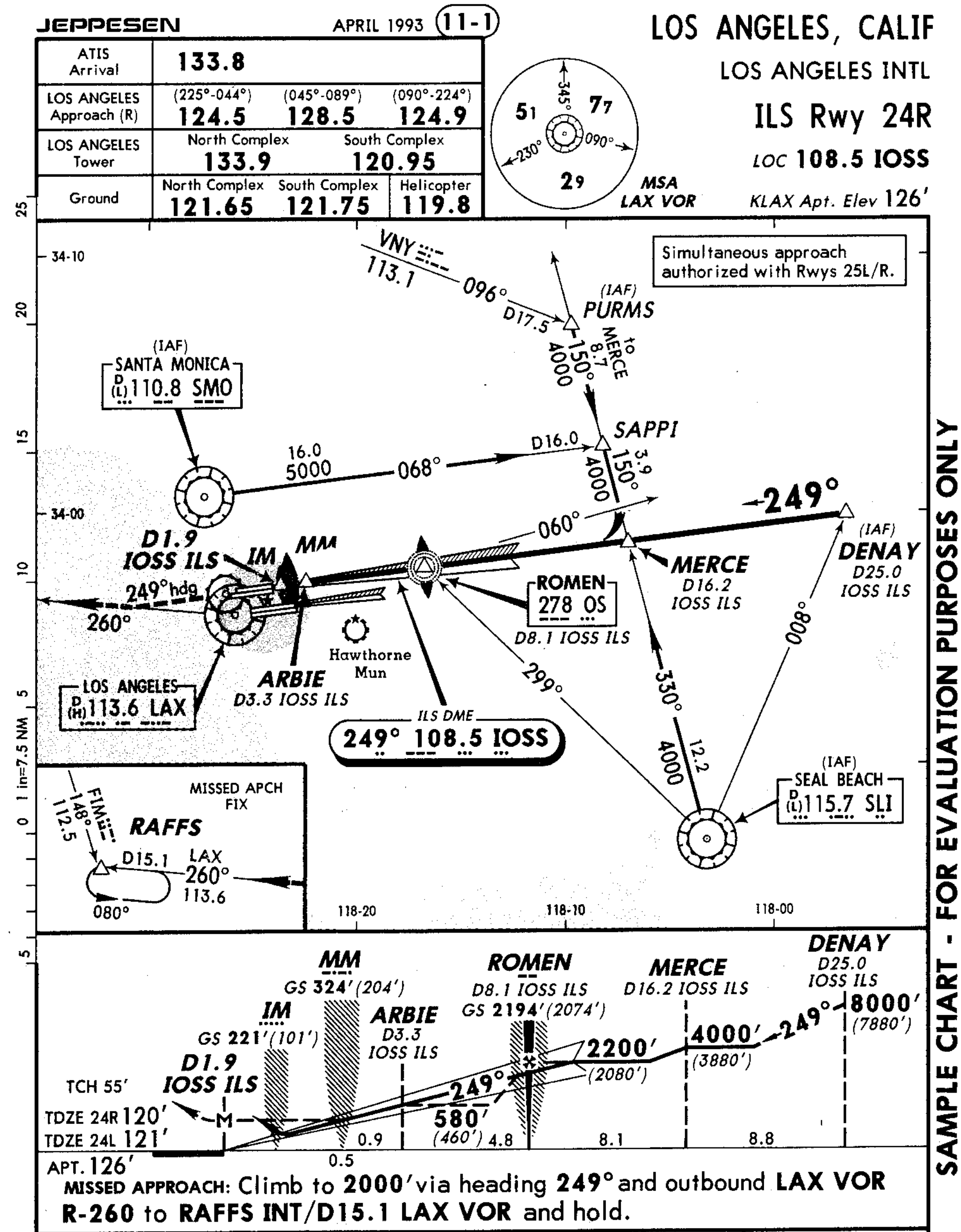


Figure B-14. Volpe/ATA Prototype IAP Chart for Los Angeles International (LAX) ILS Runway 24R



	STRAIGHT-IN LANDING RWY 24R ILS DA(H) 320'(200') FULL	TDZ or CL out	ALS out	LOC (GS out) MDA(H) 460'(340') With Arbie	ALS out	MDA(H) 580'(460') Without Arbie	ALS out	SIDESTEP LANDING RWY 24L MDA(H) 660'(539')	RAIL or ALS out
C	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 50 or 1	RVR 40 or 3/4	RVR 60 or 1¼	RVR 50 or 1	1½
D	RVR 18 or 1/2	RVR 24 or 1/2	RVR 40 or 3/4	RVR 40 or 3/4	RVR 50 or 1	RVR 50 or 1	1½	1½	2

Gnd speed-Kts	70	90	100	120	140	160
GS 3.00°	379	487	541	649	757	866
MAP at D1.9 IOSS ILS or ROMEN to MAP 6.2	5:19	4:08	3:43	3:06	2:39	2:20

Figure B-15. Jeppesen Prototype IAP Chart for Los Angeles International (LAX) ILS Runway 24R

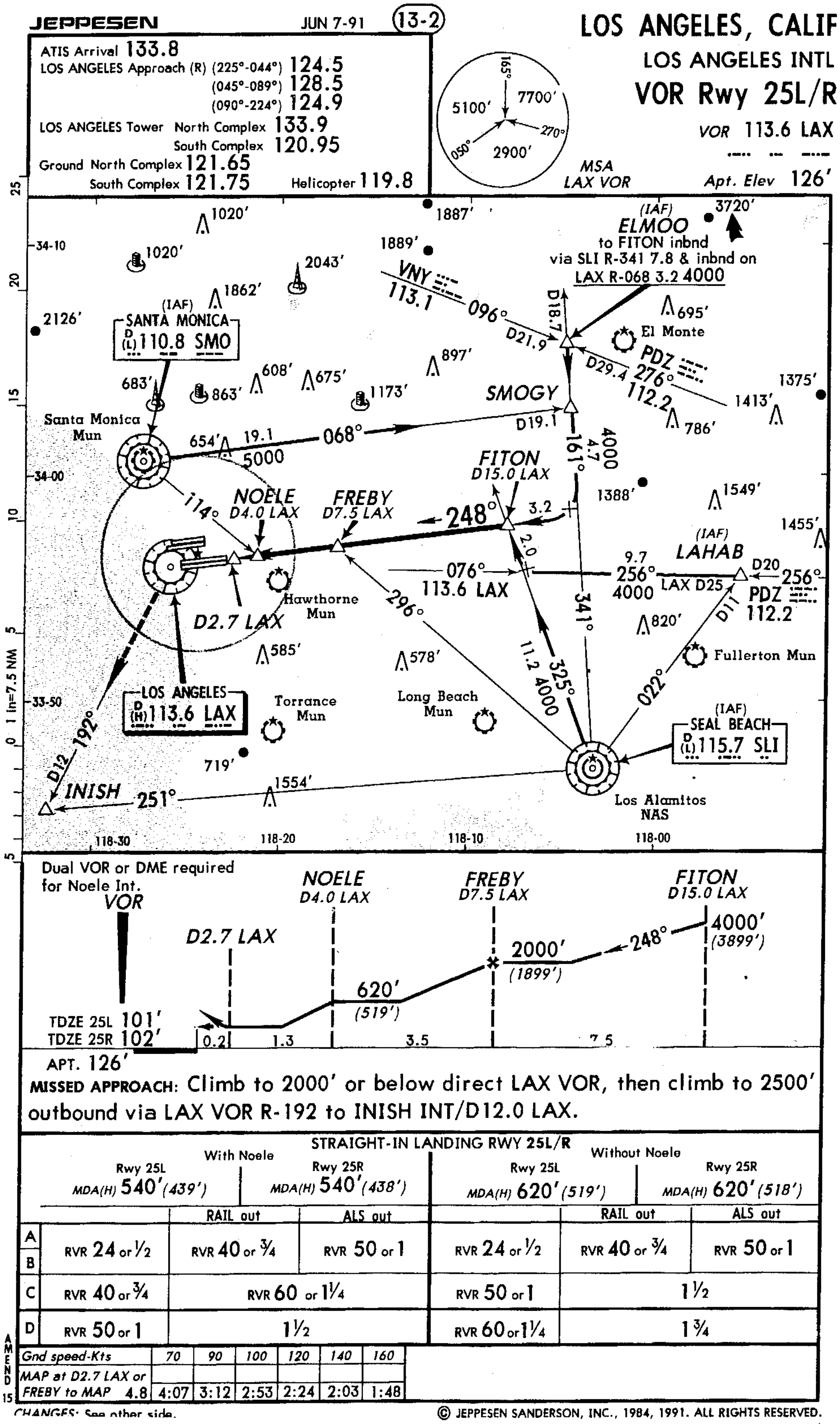


Figure B-16. Current Standard IAP Chart for Los Angeles International (LAX) VOR Runway 25 L/R

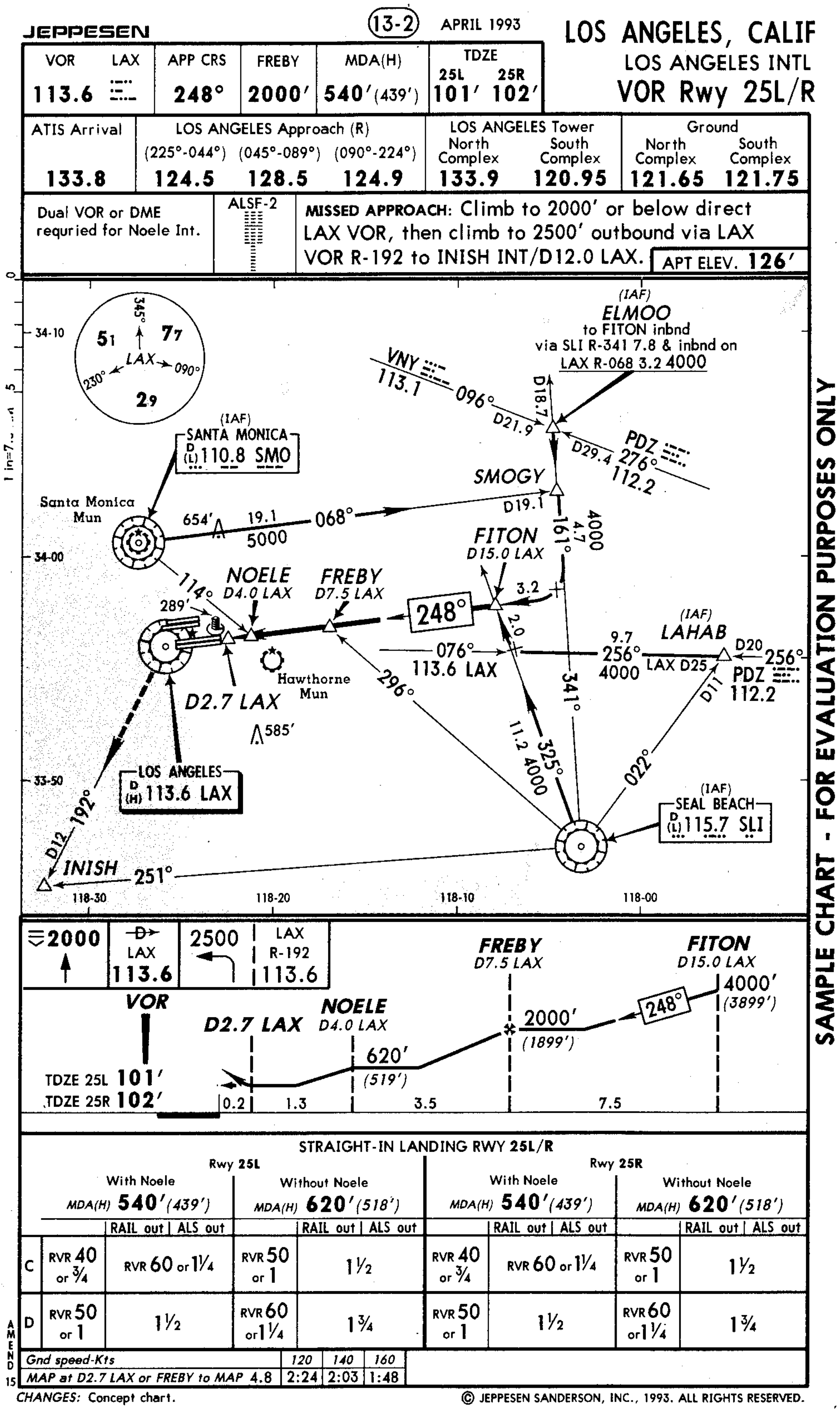


Figure B-17. Volpe/ATA Prototype IAP Chart for Los Angeles International (LAX) VOR Runway 25 L/R

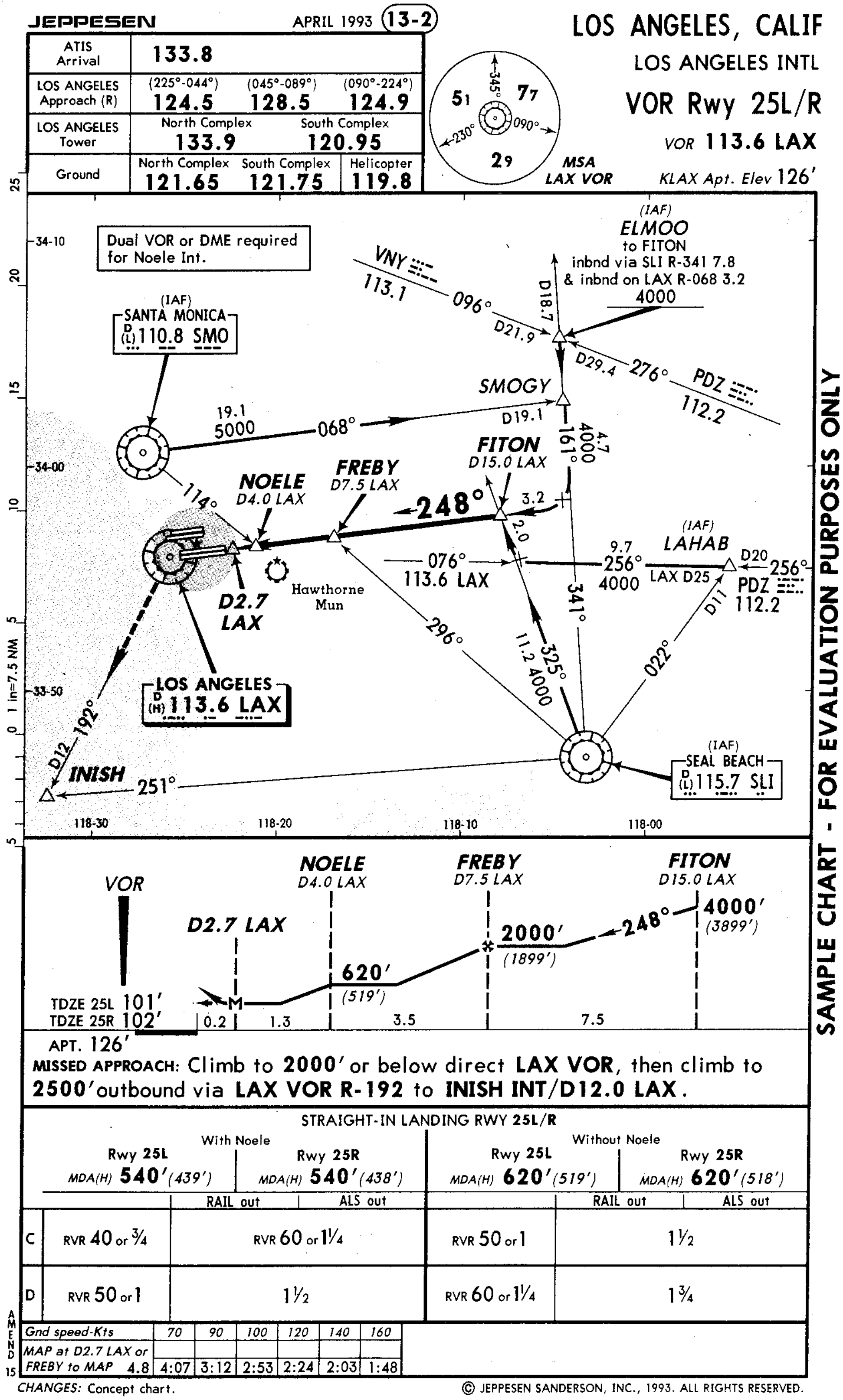


Figure B-18. Jeppesen Prototype IAP Chart for Los Angeles International (LAX) VOR Runway 25 L/R

APPENDIX C - Part 1

Volpe/ATA Prototype Chart Debriefing Data Summaries

Scaled Response Data Summaries for Each Debriefing Item

Volpe/ATA Prototype

Question 1: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The information needed to program a flight management computer or to use for quick reference in case of a last minute change in runways is contained in the top row of the Briefing Strip.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			2	3	17	15	37	# Pilots
			5.4%	8.1%	45.9%	40.5%	100.0%	% of Chart
			15.4%	30.0%	47.2%	53.6%	40.7%	% of Column
Jeppesen		2	10	7	14	11	44	# Pilots
		4.5%	22.7%	15.9%	31.8%	25.0%	100.0%	% of Chart
		100.0%	76.9%	70.0%	38.9%	39.3%	48.4%	% of Column
None	2		1		5	2	10	# Pilots
	20.0%		10.0%		50.0%	20.0%	100.0%	% of Chart
	100.0%		7.7%		13.9%	7.1%	11.0%	% of Column
SUM	2	2	13	10	36	28	91	# Pilots
	2.2%	2.2%	14.3%	11.0%	39.6%	30.8%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	5.216	0.821
Z Scores	0.783	0.634
Range Transformation	0.831	0.213
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.500	1.229
Z Scores	0.205	0.835
Range Transformation	0.680	0.264
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.200	1.874
Z Scores	0.330	1.221
Range Transformation	0.622	0.369
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.758	1.223
Z Scores	0.454	0.848
Range Transformation	0.735	0.268

Volpe/ATA Prototype

Question 2: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

For non-precision approaches to either of two runways, both TDZEs are shown and both are in bold type.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		5	16	10	1	5	37	# Pilots
		13.5%	43.2%	27.0%	2.7%	13.5%	100.0%	% of Chart
		33.3%	44.4%	45.5%	11.1%	100.0%	40.7%	% of Column
Jeppesen	3	9	19	9	4		44	# Pilots
	6.8%	20.5%	43.2%	20.5%	9.1%		100.0%	% of Chart
	75.0%	60.0%	52.8%	40.9%	44.4%		48.4%	% of Column
None	1	1	1	3	4		10	# Pilots
	10.0%	10.0%	10.0%	30.0%	40.0%		100.0%	% of Chart
	25.0%	6.7%	2.8%	13.6%	44.4%		11.0%	% of Column
SUM	4	15	36	22	9	5	91	# Pilots
	4.4%	16.5%	39.6%	24.2%	9.9%	5.5%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	3.595	1.189
Z Scores	-0.509	0.721
Range Transformation	0.457	0.261
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.045	1.033
Z Scores	-0.913	0.821
Range Transformation	0.349	0.231
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.800	1.398
Z Scores	-0.039	0.915
Range Transformation	0.542	0.261
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	3.352	1.168
Z Scores	-0.653	0.835
Range Transformation	0.414	0.253

Volpe/ATA Prototype

Question 3: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The communications frequencies are boxed and aligned horizontally in the second row of the Briefing Strip in the order in which they are used.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots		1	8	9	12	7	37
	% of Chart		2.7%	21.6%	24.3%	32.4%	18.9%	100.0%
	% of Column		10.0%	42.1%	34.6%	60.0%	63.6%	40.7%
Jeppesen	# Pilots	2	8	10	14	7	3	44
	% of Chart	4.5%	18.2%	22.7%	31.8%	15.9%	6.8%	100.0%
	% of Column	40.0%	80.0%	52.6%	53.8%	35.0%	27.3%	48.4%
None	# Pilots	3	1	1	3	1	1	10
	% of Chart	30.0%	10.0%	10.0%	30.0%	10.0%	10.0%	100.0%
	% of Column	60.0%	10.0%	5.3%	11.5%	5.0%	9.1%	11.0%
SUM	# Pilots	5	10	19	26	20	11	91
	% of Chart	5.5%	11.0%	20.9%	28.6%	22.0%	12.1%	100.0%
	% of Column	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	4.432	1.119
Z Scores	0.132	0.816
Range Transformation	0.646	0.273
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.568	1.283
Z Scores	-0.471	0.873
Range Transformation	0.471	0.271
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.100	1.792
Z Scores	-0.521	1.122
Range Transformation	0.378	0.340
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	3.868	1.360
Z Scores	-0.231	0.921
Range Transformation	0.532	0.294

Volpe/ATA Prototype

Question 4: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The consolidation of notes, approach lighting, missed approach text and airport elevation in the third row of the briefing strip.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			2	4	12	19	37	# Pilots
			5.4%	10.8%	32.4%	51.4%	100.0%	% of Chart
			22.2%	40.0%	50.0%	51.4%	40.7%	% of Column
Jeppesen	2	6	7	4	10	15	44	# Pilots
	4.5%	13.6%	15.9%	9.1%	22.7%	34.1%	100.0%	% of Chart
	66.7%	75.0%	77.8%	40.0%	41.7%	40.5%	48.4%	% of Column
None	1	2		2	2	3	10	# Pilots
	10.0%	20.0%		20.0%	20.0%	30.0%	100.0%	% of Chart
	33.3%	25.0%		20.0%	8.3%	8.1%	11.0%	% of Column
SUM	3	8	9	10	24	37	91	# Pilots
	3.3%	8.8%	9.9%	11.0%	26.4%	40.7%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimate		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	5.297	0.878
Z Scores	0.882	0.732
Range Transformation	0.855	0.207
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.341	1.627
Z Scores	0.103	1.010
Range Transformation	0.648	0.343
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.100	1.853
Z Scores	0.315	1.348
Range Transformation	0.607	0.366
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.703	1.472
Z Scores	0.443	1.010
Range Transformation	0.727	0.313

Volpe/ATA Prototype

Question 5: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The identification of the referenced navaid for the MSA by its call sign in the center of the circle.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		3	3	8	15	8	37	# Pilots
		8.1%	8.1%	21.6%	40.5%	21.6%	100.0%	% of Chart
		37.5%	16.7%	38.1%	53.6%	61.5%	40.7%	% of Column
Jeppesen	3	4	11	13	11	2	44	# Pilots
	6.8%	9.1%	25.0%	29.5%	25.0%	4.5%	100.0%	% of Chart
	100.0%	50.0%	61.1%	61.9%	39.3%	15.4%	48.4%	% of Column
None		1	4		2	3	10	# Pilots
		10.0%	40.0%		20.0%	30.0%	100.0%	% of Chart
		12.5%	22.2%		7.1%	23.1%	11.0%	% of Column
SUM	3	8	18	21	28	13	91	# Pilots
	3.3%	8.8%	19.8%	23.1%	30.8%	14.3%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	4.595	1.166
Z Scores	0.268	0.880
Range Transformation	0.672	0.290
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.705	1.268
Z Scores	-0.381	0.822
Range Transformation	0.495	0.277
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.200	1.549
Z Scores	0.123	1.032
Range Transformation	0.585	0.369
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.121	1.315
Z Scores	-0.062	0.915
Range Transformation	0.577	0.302

Question 6: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The use of radials rather than bearings to define the sectors of the MSA.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots			5	10	11	10	36
	% of Chart			13.9%	27.8%	30.6%	27.8%	100.0%
	% of Column			38.5%	47.6%	44.0%	33.3%	40.0%
Jeppesen	# Pilots		1	6	7	12	18	44
	% of Chart		2.3%	13.6%	15.9%	27.3%	40.9%	100.0%
	% of Column		100.0%	46.2%	33.3%	48.0%	60.0%	48.9%
None	# Pilots			2	4	2	2	10
	% of Chart			20.0%	40.0%	20.0%	20.0%	100.0%
	% of Column			15.4%	19.0%	8.0%	6.7%	11.1%
SUM	# Pilots		1	13	21	25	30	90
	% of Chart		1.1%	14.4%	23.3%	27.8%	33.3%	100.0%
	% of Column		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=36)	Mean	Standard Deviation
Raw Scores	4.722	1.031
Z Scores	0.336	0.656
Range Transformation	0.714	0.251
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.909	1.158
Z Scores	0.441	0.742
Range Transformation	0.751	0.272
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.400	1.075
Z Scores	0.255	0.816
Range Transformation	0.635	0.304
All Pilots (N=90)	Mean	Standard Deviation
Raw Scores	4.778	1.099
Z Scores	0.378	0.712
Range Transformation	0.723	0.267

Volpe/ATA Prototype

Question 7: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The use of sectional chart notation for the altitudes in the MSA.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots	1	12	10	7	3	2	35
	% of Chart	2.9%	34.3%	28.6%	20.0%	8.6%	5.7%	100.0%
	% of Column	16.7%	66.7%	37.0%	38.9%	23.1%	28.6%	39.3%
Jeppesen	# Pilots	5	4	14	8	9	4	44
	% of Chart	11.4%	9.1%	31.8%	18.2%	20.5%	9.1%	100.0%
	% of Column	83.3%	22.2%	51.9%	44.4%	69.2%	57.1%	49.4%
None	# Pilots		2	3	3	1	1	10
	% of Chart		20.0%	30.0%	30.0%	10.0%	10.0%	100.0%
	% of Column		11.1%	11.1%	16.7%	7.7%	14.3%	11.2%
SUM	# Pilots	6	18	27	18	13	7	89
	% of Chart	6.7%	20.2%	30.3%	20.2%	14.6%	7.9%	100.0%
	% of Column	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	3.143	1.240
Z Scores	-0.831	0.989
Range Transformation	0.365	0.270
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.545	1.454
Z Scores	-0.526	1.074
Range Transformation	0.460	0.322
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.600	1.265
Z Scores	-0.305	0.830
Range Transformation	0.460	0.302
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	3.393	1.354
Z Scores	-0.621	1.023
Range Transformation	0.423	0.300

Volpe/ATA Prototype

Question 8: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The use of a box around the approach course in the Plan View.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots		1	7	9	10	10	37
	% of Chart		2.7%	18.9%	24.3%	27.0%	27.0%	100.0%
	% of Column		16.7%	28.0%	47.4%	45.5%	62.5%	40.7%
Jeppesen	# Pilots	3	5	16	7	8	5	44
	% of Chart	6.8%	11.4%	36.4%	15.9%	18.2%	11.4%	100.0%
	% of Column	100.0%	83.3%	64.0%	36.8%	36.4%	31.2%	48.4%
None	# Pilots			2	3	4	1	10
	% of Chart			20.0%	30.0%	40.0%	10.0%	100.0%
	% of Column			8.0%	15.8%	18.2%	6.2%	11.0%
SUM	# Pilots	3	6	25	19	22	16	91
	% of Chart	3.3%	6.6%	27.5%	20.9%	24.2%	17.6%	100.0%
	% of Column	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	4.568	1.168
Z Scores	0.229	0.776
Range Transformation	0.671	0.269
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.614	1.401
Z Scores	-0.462	0.970
Range Transformation	0.469	0.309
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.400	0.966
Z Scores	0.341	0.813
Range Transformation	0.672	0.183
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.088	1.339
Z Scores	-0.093	0.942
Range Transformation	0.573	0.297

Volpe/ATA Prototype

Question 9: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The depiction of only those obstacles and airports within 5 miles of the approach course in the Plan View.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe	7	5	3	8	7	7	37	# Pilots
	18.9%	13.5%	8.1%	21.6%	18.9%	18.9%	100.0%	% of Chart
	50.0%	29.4%	37.5%	33.3%	46.7%	53.8%	40.7%	% of Column
Jeppesen	7	6	4	14	7	6	44	# Pilots
	15.9%	13.6%	9.1%	31.8%	15.9%	13.6%	100.0%	% of Chart
	50.0%	35.3%	50.0%	58.3%	46.7%	46.2%	48.4%	% of Column
None		6	1	2	1		10	# Pilots
		60.0%	10.0%	20.0%	10.0%		100.0%	% of Chart
		35.3%	12.5%	8.3%	6.7%		11.0%	% of Column
SUM	14	17	8	24	15	13	91	# Pilots
	15.4%	18.7%	8.8%	26.4%	16.5%	14.3%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	3.649	1.798
Z Scores	-0.393	1.221
Range Transformation	0.494	0.378
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.591	1.633
Z Scores	-0.443	1.100
Range Transformation	0.482	0.346
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	2.800	1.135
Z Scores	-0.850	0.858
Range Transformation	0.308	0.219
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	3.527	1.662
Z Scores	-0.467	1.125
Range Transformation	0.468	0.350

Question 10: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The depiction of the controlling obstacle in the Plan View even if it is outside 5 miles.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe	8	8	7	5	3		31	# Pilots
	25.8%	25.8%	22.6%	16.1%	9.7%		100.0%	% of Chart
	50.0%	61.5%	33.3%	45.5%	42.9%		44.9%	% of
Jeppesen	6	5	13	6	3		33	# Pilots
	18.2%	15.2%	39.4%	18.2%	9.1%		100.0%	% of Chart
	37.5%	38.5%	61.9%	54.5%	42.9%		47.8%	% of Column
None	2		1		1	1	5	# Pilots
	40.0%		20.0%		20.0%	20.0%	100.0%	% of Chart
	12.5%		4.8%		14.3%	100.0%	7.2%	% of Column
SUM	16	13	21	11	7	1	69	# Pilots
	23.2%	18.8%	30.4%	15.9%	10.1%	1.4%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=31)	Mean	Standard Deviation
Raw Scores	2.581	1.311
Z Scores	-1.295	0.864
Range Transformation	0.252	0.276
Pilots who flew the Jeppeson Chart (N=33)	Mean	Standard Deviation
Raw Scores	2.848	1.202
Z Scores	-0.972	0.832
Range Transformation	0.306	0.253
Pilots who did not fly (N=5)	Mean	Standard Deviation
Raw Scores	3.200	2.280
Z Scores	-0.668	1.595
Range Transformation	0.410	0.464
All Pilots (N=69)	Mean	Standard Deviation
Raw Scores	2.754	1.333
Z Scores	-1.095	0.919
Range Transformation	0.289	0.280

Volpe/ATA Prototype

Question 11: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The deletion of the middle marker information from the Plan View while leaving it in the Profile View.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe	4	4	6	11	6	6	37	# Pilots
	10.8%	10.8%	16.2%	29.7%	16.2%	16.2%	100.0%	% of Chart
	57.1%	28.6%	30.0%	40.7%	40.0%	75.0%	40.7%	% of Column
Jeppesen	3	7	12	13	7	2	44	# Pilots
	6.8%	15.9%	27.3%	29.5%	15.9%	4.5%	100.0%	% of Chart
	42.9%	50.0%	60.0%	48.1%	46.7%	25.0%	48.4%	% of Column
None		3	2	3	2		10	# Pilots
		30.0%	20.0%	30.0%	20.0%		100.0%	% of Chart
		21.4%	10.0%	11.1%	13.3%		11.0%	% of Column
SUM	7	14	20	27	15	8	91	# Pilots
	7.7%	15.4%	22.0%	29.7%	16.5%	8.8%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates

Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	3.784	1.548
Z Scores	-0.384	1.126
Range Transformation	0.502	0.345

Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.455	1.266
Z Scores	-0.568	0.797
Range Transformation	0.437	0.272

Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.400	1.174
Z Scores	-0.421	0.937
Range Transformation	0.433	0.261

All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	3.582	1.375
Z Scores	-0.477	0.952
Range Transformation	0.463	0.301

Volpe/ATA Prototype

Question 12: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The deletion of the Morse Code for the primary navaid from the Plan View.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM	
Volpe		5	4	5	10	6	7	37	# Pilots
		13.5%	10.8%	13.5%	27.0%	16.2%	18.9%	100.0%	% of Chart
		27.8%	18.2%	55.6%	55.6%	54.5%	53.8%	40.7%	% of Column
Jeppesen		10	18	1	6	4	5	44	# Pilots
		22.7%	40.9%	2.3%	13.6%	9.1%	11.4%	100.0%	% of Chart
		55.6%	81.8%	11.1%	33.3%	36.4%	38.5%	48.4%	% of Column
None		3		3	2	1	1	10	# Pilots
		30.0%		30.0%	20.0%	10.0%	10.0%	100.0%	% of Chart
		16.7%		33.3%	11.1%	9.1%	7.7%	11.0%	% of Column
SUM		18	22	9	18	11	13	91	# Pilots
		19.8%	24.2%	9.9%	19.8%	12.1%	14.3%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	3.784	1.652
Z Scores	-0.340	1.229
Range Transformation	0.510	0.359
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	2.795	1.692
Z Scores	-1.014	1.039
Range Transformation	0.307	0.347
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.100	1.729
Z Scores	-0.652	1.109
Range Transformation	0.360	0.367
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	3.231	1.726
Z Scores	-0.700	1.160
Range Transformation	0.395	0.363

Volpe/ATA Prototype

Question 13: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The depiction of the "up and out" missed approach maneuvers by icons in the Profile View.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM	
Volpe				1	3	14	19	37	# Pilots
				2.7%	8.1%	37.8%	51.4%	100.0%	% of Chart
				20.0%	42.9%	42.4%	52.8%	40.7%	% of Column
Jeppesen		4	5	2	4	15	14	44	# Pilots
		9.1%	11.4%	4.5%	9.1%	34.1%	31.8%	100.0%	% of Chart
		100.0%	83.3%	40.0%	57.1%	45.5%	38.9%	48.4%	% of Column
None			1	2		4	3	10	# Pilots
			10.0%	20.0%		40.0%	30.0%	100.0%	% of Chart
			16.7%	40.0%		12.1%	8.3%	11.0%	% of Column
SUM		4	6	5	7	33	36	91	# Pilots
		4.4%	6.6%	5.5%	7.7%	36.3%	39.6%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	5.378	0.758
Z Scores	0.916	0.620
Range Transformation	0.874	0.179
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.432	1.676
Z Scores	0.160	1.076
Range Transformation	0.663	0.359
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.600	1.430
Z Scores	0.619	1.230
Range Transformation	0.725	0.276
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.835	1.408
Z Scores	0.518	0.993
Range Transformation	0.756	0.303

Volpe/ATA Prototype

Question 14: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The depiction of the TDZE for the intended runway in bold type.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots	1		3	6	17	10	37
	% of Chart	2.7%		8.1%	16.2%	45.9%	27.0%	100.0%
	% of Column	20.0%		23.1%	26.1%	51.5%	66.7%	40.7%
Jeppesen	# Pilots	3	1	8	15	12	5	44
	% of Chart	6.8%	2.3%	18.2%	34.1%	27.3%	11.4%	100.0%
	% of Column	60.0%	50.0%	61.5%	65.2%	36.4%	33.3%	48.4%
None	# Pilots	1	1	2	2	4		10
	% of Chart	10.0%	10.0%	20.0%	20.0%	40.0%		100.0%
	% of Column	20.0%	50.0%	15.4%	8.7%	12.1%		11.0%
SUM	# Pilots	5	2	13	23	33	15	91
	% of Chart	5.5%	2.2%	14.3%	25.3%	36.3%	16.5%	100.0%
	% of Column	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	4.838	1.093
Z Scores	0.486	0.693
Range Transformation	0.747	0.230
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.068	1.283
Z Scores	-0.165	0.842
Range Transformation	0.569	0.285
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.700	1.418
Z Scores	-0.136	0.960
Range Transformation	0.517	0.277
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	4.341	1.284
Z Scores	0.103	0.851
Range Transformation	0.636	0.277

Volpe/ATA Prototype

Question 15: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The use of bold type in the Minimums area for the decision altitudes for straight-in landings to the intended runways.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		2	2	5	15	13	37	# Pilots
		5.4%	5.4%	13.5%	40.5%	35.1%	100.0%	% of Chart
		66.7%	50.0%	35.7%	40.5%	39.4%	40.7%	% of Column
Jeppesen		1	1	6	17	19	44	# Pilots
		2.3%	2.3%	13.6%	38.6%	43.2%	100.0%	% of Chart
		33.3%	25.0%	42.9%	45.9%	57.6%	48.4%	% of Column
None			1	3	5	1	10	# Pilots
			10.0%	30.0%	50.0%	10.0%	100.0%	% of Chart
			25.0%	21.4%	13.5%	3.0%	11.0%	% of Column
SUM		3	4	14	37	33	91	# Pilots
		3.3%	4.4%	15.4%	40.7%	36.3%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=37)	Mean	Standard Deviation
Raw Scores	4.946	1.104
Z Scores	0.522	0.734
Range Transformation	0.761	0.249
Pilots who flew the Jeppeson Chart (N=44)	Mean	Standard Deviation
Raw Scores	5.182	0.922
Z Scores	0.670	0.527
Range Transformation	0.821	0.198
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.600	0.843
Z Scores	0.348	0.655
Range Transformation	0.688	0.259
All Pilots (N=91)	Mean	Standard Deviation
Raw Scores	5.022	1.000
Z Scores	0.574	0.635
Range Transformation	0.782	0.228

Volpe/ATA Prototype

Question 16: *Do you need circle-to-land minimums on charts for Part 121 operations?*

Chart Flown		Yes	No	No Answer	SUM	
Volpe		19	8	10	37	# Pilots
		51.4%	21.6%	27.0%	100.0%	% of Chart
		47.5%	32.0%	38.5%	40.7%	% of Column
Jeppesen		11	17	16	44	# Pilots
		25.0%	38.6%	36.4%	100.0%	% of Chart
		27.5%	68.0%	61.5%	48.4%	% of Column
None		10			10	# Pilots
		100.0%			100.0%	% of Chart
		25.0%			11.0%	% of Column
SUM		40	25	26	91	# Pilots
		44.0%	27.5%	28.6%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	% of Column

Volpe/ATA Prototype

Question 17: *Do you prefer the (Volpe/ATA) prototype format?*

Chart Flown	Yes	No	No Answer	SUM	
Volpe	18	1		19	# Pilots
	94.7%	5.3%		100.0%	% of Chart
	48.6%	33.3%		47.5%	% of Column
Jeppesen	9	2		11	# Pilots
	81.8%	18.2%		100.0%	% of Chart
	24.3%	66.7%		27.5%	% of Column
None	10			10	# Pilots
	100.0%			100.0%	% of Chart
	27.0%			25.0%	% of Column
SUM	37	3		40	# Pilots
	92.5%	7.5%		100.0%	% of Chart
	100.0%	100.0%		100.0%	% of Column

APPENDIX C - Part 2

Volpe/ATA Prototype Chart Debriefing Data Summaries

Part 2 - Crew Comments Regarding Each Chart Design Feature

Chart Type:	**Volpe/ATA Prototype**
Question: 1.	The information needed to program a flight management computer or to use for quick reference in case of a last minute change in runways is contained in the top row of the Briefing Strip.

Comments
It is easier to conduct the briefing; all of the information is right where you can use it easily; don't have to look all over the chart; it will help standardize the briefing.
Reads better left to right than up and down.
Would like having the briefing information separated in some way so it stands out.
On several of the prototype charts the Briefing Strip presents the West and East frequencies in an "opposite" orientation. The name of the communication facilities should be bolded to make it easier to locate needed one.
Need to add runway length to complete the strip.
For briefing don't need the frequency line, should at least move it down to the bottom of the strip; don't brief frequencies.
Vertical arrangement of frequencies is better.
On most aircraft, the chart is held by the clip on the yoke, part of the Briefing Strip would be under the clip (should be able to see entire Briefing Strip).
Eliminate TDZE and TCH and follow it immediately with the text of the missed approach procedure; don't know who really uses TDZE and TCH.
The standard chart and the prototype (J) we flew, forces you to read the chart which is good. Feels the Briefing Strip would create bad habits, i.e., not reading the entire chart.
For briefing it is good, but to program the FMS, don't need any of this information.
The whole top looks too busy; too much information; it's doubling up the information already on the chart; don't need a line to brief the approach; it's too drastic a change; used to the standard don't like the change.
Could give up the top line of the Briefing Strip, if the information was bolded wherever it appeared on the rest of the chart.
We set heading, frequencies, and minimums first, then the crossing fix is briefed. Recommend the Briefing Strip be arranged in this order.
If a quick reference is needed, went right to the bottom where it was in a more familiar location.
Would like DME and crossing altitudes in the Briefing Strip.
Missed MSA area as part of the briefing because it was in the plan view.

Chart Type: Volpe/ATA Prototype Question: 1. The information needed to program a flight management computer or to usequick reference in case of a last minute change in runways is contained in the top row of the Briefing Strip. (Continued)
Comments
Would like greater use of graphic technique to help briefing; pilot is pictorially oriented, too many words.
The missed approach description is better located near the profile which helps you understand the written procedure.
Typically, you only need "up and out" procedure when you execute a missed approach since you will be vectored by ATC. Don't need the full missed approach procedure.
Although not sure, the Briefing Strip may be useful to a "glass cockpit".

Chart Type: Volpe/ATA Prototype Question: 2. For non-precision approaches to either of two runways, both TDZEs are shown and both are in bold type.
Comments
It's better; the format is better.
TDZE should be included in a "runway information box."
Only need to show both if there is a substantial difference.
The TCH information is somewhat superfluous; don't think it's useful information; don't use it.
Neutral, don't have any real feelings about it.
TDZE should be shown in the profile view near the end of the approach.
TCH is in two places on the chart, never use it.
Rarely use TDZE. Only for a very few approaches and very low minimums; don't use it.
Once you see the runway, it doesn't matter any more.
Only use TCH information, never look at TDZE.

Chart Type:	**Volpe/ATA Prototype**
Question: 3.	The communications frequencies are boxed and aligned horizontally in the second row of the Briefing Strip in the order in which they are used.

Comments
Like the horizontal format and bolding; horizontal format is easier to read; seems to take less space on the chart.
Like the format but prefer information lower on the strip/chart; rarely read from the chart; occupies valuable real estate.
Primary frequencies should be bolder than secondary frequencies. All in bold loses the impression; an improvement would be to bold the names of the facilities (eyes could find the desired one, faster).
Like the bold print, but neutral on horizontal format.
Put East and West in the correct orientation (West first, then East).
Don't need ATIS and approach frequencies. They're already on the 10-9.
Horizontal format may be a little worse, probably because used to vertical format, but could get used to it.
Neutral on horizontal or vertical format.
Bold only TOWER and GROUND facilities.
Prefer frequencies arranged vertically, it seems easier to find what you want; used to looking in the left corner for communication information.
Replace the word "Regional" with the name of the actual facility name, ie., on the Dallas chart replace it with "DFW".
Instead of East or West, prefer which runway the frequency is for.
Would like airport ramp frequency included on chart.
If the approach is to the West, have the boldface only for the West and vice versa.
Having the approach frequencies in the communications strip is pretty handy and real quick to use.
West-East reversed orientation is not a problem.

Chart Type:	**Volpe/ATA Prototype**
Question: 4.	The consolidation of notes, approach lighting, missed approach text and airport elevation in the third row of the briefing strip.

Comments

General Comments

For briefing everything needed is right there; used to the standard chart but could get to like this chart.
Add runway length to the Briefing Strip and it will completely eliminate the need to refer to 10-9.
Runway length and width should be added, aids in the perception of the runway.
Include the runway length as part of the profile view information.

Comments Related to Approach Lighting Information

Approach lighting is a good feature, but need to add type, ie., VASI, PAPI, REILS, etc.; adding type is an aid in assuring landing on correct runway.
Approach lighting is an excellent addition; saves time getting the 10-9 out, especially for non-precision approaches; helps to know what you're going to see when you break out.
For parallel runways, the approach lighting for both, to include type, should be on the plate and the runways identified (left/right) especially for a non-precision approach and when the lighting systems are different.
Consider putting lighting information in first row of the Briefing Strip.

Comments Related to Notes

Equipment and procedures notes can be grouped in a notes box, however, altitude related notes are better in the profile view.
Like notes in one location; better than having them scattered all over the chart.
Like notes grouped in one location, but not necessarily in the heading of the chart.
Notes should be placed on the chart near where they are referenced/used; notes seem to lose their importance when they are grouped.
Consider putting all notes just below minimums area, but above the ground speed section to declutter the chart.
Notes should be put in a box in the plan view, similar to the other prototype (J) chart.
Separate notes with something like a bullet/dash for readability.
Too much information in the Briefing Strip, don't need all the notes for the briefing.

Chart Type:	**Volpe/ATA Prototype**
Question: 4.	The consolidation of notes, approach lighting, missed approach text and airport elevation in the third row of the briefing strip. (Continued)

Comments

Comments Related to Missed Approach Information

Like the missed approach text in the briefing area of the chart; it's part of the briefing, like having it up high on the chart; it cleans up the profile view
Missed approach text in good location but an improvement would be to bold the key elements similar to the other (J) prototype.
Reduce the emphasis of the frequencies, give the missed approach procedure more room which keeps the briefing information in the "correct" order.

Comments Related to Airport Elevation Information

Prefer missed approach text in the profile view; words should be with profile information; once you shoot the approach, eyes are in the profile view and prefer text not icons.
Airport elevation should be part of the header near the name of the airport; in the upper right corner of the chart.
Like airport elevation location in the third row; logical place to put airport elevation.
Airport elevation boxed and bolded stands out more than current chart.
Neutral on the location of the airport elevation.

Chart Type:	**Volpe/ATA Prototype**
Question: 5.	The identification of the referenced navaid for the MSA by its call sign in the center of the circle.

Comments
Needs symbol (VOR/Airport) to clearly identify MSA and spell it out; include full identifier, type and call sign; nice to know where it's measured from.
Location in the plan view is good, however, current format on standard chart is better.
Consider showing minimum altitudes on the borders of the map view, with radials shown from the referenced navaid.
For glass cockpit, KDFW is really meaningful because it can be seen it on NAV display; no confusion between airport and VOR since airport would have a "K" as part of the identifier.
MSA location on the plan view may not always be possible on a chart that is crowded with other information.
On the map view the MSA should always be shown in the same location for easy reference.

Chart Type:	**Volpe/ATA Prototype**
Question: 6.	The use of radials rather than bearings to define the sectors of the MSA.

Comments
Like it. Don't have to convert it. This makes better sense.
The concept of radials is great, where they are applicable; when the reference is an NDB, bearings would have to be used.
Neutral, one way or the other.
Measuring with the micrometer and cutting with an ax. All the pilot needs to know roughly, if he is (on the Dallas chart) North of Dallas, he should be above that sector's MSA and South of Dallas, he should be above that sector's MSA.

Chart Type:	**Volpe/ATA Prototype**
Question: 7.	The use of sectional chart notation for the altitudes in the MSA.

Comments
Prefer the full number, there is no doubt about the number; like the old way which can't be misread; got the room, why not put the whole number, i.e., 2600, etc.
Like the old style better, you've got the room, why not put 2600, etc.
Like sectional notation as shown on prototype.
It's better than the current chart.
Like the current, but could live with it.
Neutral, no preference; have to get used to it.
Could be confusing to show altitudes above 10,000 feet by sectional notation.

Chart Type: **Volpe/ATA Prototype**
Question: 8. The use of a box around the approach course in the Plan View.

Comments
Don't need it. Use what's in the Briefing Strip and primary navaid data.
Neutral; could get used to it; slight improvement.
The bolding is better on the other prototype (J) chart; easier to see, but could be bolder.
Approach course is shown in four places on the chart, overemphasized.
Significantly better, it looks lost on the current (standard) chart; it's good; it stands out, the box is user friendly.
Like the box around the approach course in the profile view, but not sure in the plan view. Too many boxes already in the plan view.
Don't like sideways number presentation of approach course (173^0 on Dallas/Ft Worth, TX chart). Not natural for readability.

Chart Type: **Volpe/ATA Prototype**
Question: 9. The depiction of only those obstacles and airports within 5 miles of the approach course in the Plan View.

Comments
Keep airports within plan view area. Aids in knowing what type of air traffic in area; information of other airports which may be used; aids in maintaining orientation.
Want to have both obstacles and airports for situational awareness and safety; it's not confusing information, rather, it's necessary information.
Like to have all significant obstacles near the approach shown on the plan view.
In difficult terrain, the major obstacles should be shown regardless of distance from the approach course; distance doesn't have as much to do with it as the height of obstacles.
Obstacle information should remain unchanged; keep black arrow for highest obstacle; with regard to depiction of obstacles, prefer current standard chart; like to have miniature map when on visual or to check on ATC.
Consider adding topographical information such a contours, especially in mountainous areas. Vital in mountainous areas if executing a ATC vectored (non-published) missed approach.
Obstacles outside the 5 mile criterion should be removed; like it clean; take out anything that is not needed; protected by the MSA anyway, simplicity is better; it's good, a lot of clutter removed.
Want all of the airports that are within the chart plan view area, however, obstacles can be removed outside the 5 mile criterion.
On a solid instrument approach, no need to depict airports outside the 5 mile criterion.
Other airports are on the 10-9, don't need this information on IAP charts.

Chart Type: **Volpe/ATA Prototype** **Question:** 10. The depiction of the controlling obstacle in the Plan View even if it is outside 5 miles.	

Comments
Don't need controlling obstacle information on chart; don't care about it.
Clutters the chart; don't believe it helps one bit.
Want to know that the chart keeps me clear. Don't want know why they made the approach the way they did; the people who made the chart know about those obstacles when they set the minimums.
Wouldn't mind having it on the chart. Information that prevents you from flying a sloppy approach; obstacle information that would be nice to know.
Although rarely need to know controlling obstacle information, good to have when you have malfunctions or problems. Nice to know what affects the minimums, e.g., 900' tower at the middle marker.
It's nice to know in night VFR if the obstacle is of significant height.
Consider putting controlling obstacle information in the profile view.

Chart Type: **Volpe/ATA Prototype** **Question:** 11. The deletion of the middle marker information from the Plan View while leaving it in the Profile View.	

Comments
For consistency, it should remain in both views. It's misleading to see an outer marker and no middle marker in the plan view, but there's a middle marker in the profile view.
Middle marker information should be displayed on the plan view; should be on the plan view but could be displayed with a smaller symbol.
It makes it clearer to delete the information from the plan view, however, it's needed in the profile view; take it out, don't use middle marker information; middle marker information is useless; in addition delete the feathers on the ILS charts.
Tends to declutter the plan view, but neutral one way or the other; neutral, uses only outer marker information on the plan view.
Category 2 approaches would need the information in the plan view.
During an approach about 80% of the time is spent using the information in the profile view, middle marker information should be correspondingly bigger/more prominent than presently displayed.

Chart Type:	**Volpe/ATA Prototype**
Question: 12.	The deletion of the Morse Code for the primary navaid from the Plan View.

Comments
Prefer to keep it within the primary navaid plan view box; should be on the plan view where it is used, it is also consistent with other navaid displays.
Like it in the briefing strip, but also keep it with primary navaid with more contrast.
Like it in the briefing strip, don't need it elsewhere; only need it once.
This information would be hidden by the clip holding the approach plate. Would have to move the plate around in order to see it.
Neutral about it overall; generally neutral, it will take some time to get used to it.
Never look at the "shadow box", remove entire box.

Chart Type:	**Volpe/ATA Prototype**
Question: 13.	The depiction of the "up and out" missed approach maneuvers by icons in the Profile View.

Comments

Comments Related to the Use of Icons

Pilots are better at looking at pictures than reading. It gives the required "up and out".
You can glance at the icon presentation and pretty much tell what you're supposed to do; you know what to do a lot quicker; that is the kind of shorthand for quick reference.
The icon concept should just present up and out. Through training pilots will learn that up and out may not be the complete missed approach procedure; can learn the icons quickly; it's something that's going to require training to use.
Should limit the use of icons to two boxes. Too difficult to read more than that; "up and out" is fine, four or more icons becomes confusing; as long as the icon depictions don't get too crazy, tend now to make a mental picture of "up and out" procedure.
Include the missed approach point (MAP) information in icon format. Especially if an early miss is called. It's required to fly to the MAP before you change altitude. For a non-precision approach the DME to the MAP should be clearly depicted and included in the icon.
Concerned about the ability of icons to depict complex "up and out" procedures.
Not comfortable with the use of icons, but could learn.
Don't trust the depictions of the "up and out" by icons, especially in quick situations. Prefer the written procedure.
Want entire MAP in icon format, but need verbiage above for confidence.
The icons that indicate a right or left turn should include a heading, it's going to give you an intercept to a radial, "finish what you started".

Chart Type:	**Volpe/ATA Prototype**
Question: 13.	The depiction of the "up and out" missed approach maneuvers by icons in the Profile View. (Continued)

Comments
Potential problem, if only "up and out" is displayed by icons, complete MAP procedure may not be flown.
Prefer the text in the profile view with only one icon box showing the arrow and altitude.
In terms of the icon format, signs and symbols should conform to the graphic symbology that already exists, e.g., don't like the depiction of "*climb to* an altitude or *below*" by bars or chevrons. Too many conventions to learn.
The direction of the arrows in the icons are "at odds" with all of the other graphic directions (north up vs. heading up); arrows are confusing (initial arrow, does it mean to climb straight ahead or climb on the named radial).
The difference between the solid and the broken line to separate icon frames does not appear to be consistent in the icon examples.
Prefer to have "up and out" icons placed directly at the end of the approach profile.
The written words for the missed approach procedure are better presented in the other (J) prototype. Like the bolding of the important elements; suggest adding emphasis to the missed approach procedure narrative.
Use only initial heading and altitude for "up and out", however, not necessarily in an icon format; all that's needed for a missed approach is a display of heading, navaid information and altitude, but it could be in words.
The published missed approach procedure is very rarely used, instructions should simply be to hold on approach heading until otherwise vectored.
Put the icons up with the text in the Briefing Strip, don't look at the profile section during the approach; don't look at the profile information after the middle marker, suggest moving missed approach information to include the icons higher up on the chart.

Comments Related to Bolding of Icon Information

Bolding of icon information as shown on prototype charts is fine; bolding is good.
Bold the radials not the frequencies. Frequency already set doesn't need to be bolded; the radial information should be bolded because it cannot be preset, however within the icons frequency information should be above the radial.
The radial should be bolded; bold the radial or nothing.
Frequency should be bolded but that's airplane particular; bold the frequency information which is what you need at that time.
Bold only what needs to be set or selected.
Too much bolding in charts overall defeats the purpose, care should be used in bolding.

Chart Type: **Volpe/ATA Prototype** **Question:** 13. The depiction of the "up and out" missed approach maneuvers by icons in the Profile View. (Continued)
Comments
Neither frequency or radials should be bolded, the first box should be bolder for attention, one shouldn't mistake the numbers in frequency or radial box as altitude information in the heat of the moment.

Other Related Comments

The profile should contain VDP for every approach.
Consider cumulative DME in the profile.

Chart Type: **Volpe/ATA Prototype** **Question:** 14. The depiction of the TDZE for the intended runway in bold type.
Comments
Only the primary (intended) runway should be bold; intended runway should be bold, parallel should not be bold; the other is probably there to do a sidestep, maybe a TERPS requirement.
Why do they bother with the TDZE for the other (parallel) runway. Pilot's are not going use that information. If you're going to land on the other runway, the plate for that runway will be used.
If there are parallel runways, they both should be bolded.
Neutral, doesn't matter; not a big deal, one way or the other; it's an improvement, but not much.
If there is no possibility of a sidestep, the TDZE for the non-intended runway should not be shown.
TDZE doesn't warrant bolding, it should be reserved for more important information.
Only need both TDZEs if there is a significant difference.
TDZE and the TCH take up too much space and add clutter, we don't use this information.
TCH is important. Everybody uses this information.
TCH is not significant to us. When you're coming in and you're going to land it's worthless information.

Chart Type:	**Volpe/ATA Prototype**
Question: 15.	The use of bold type in the Minimums area for the decision altitudes for straight-in landings to the intended runways.

Comments
Stands out so much better; anything that is easy to read is better; it really helps you get the key information; like to see "primary information".
Good, but bold all minima; all altitudes should be bolded the same.
May be better if there was even more contrast between the ILS altitude and the others; make the decision height, which is relevant to the approach being flown, more prominent.
Minimums for a sidestep should also be bolded.
It's alright not to bold sidestep minimums since it would be double checked since it is not commonplace.
Don't know why sidestep information is there, when you're told to do a sidestep you're going to pull the plate for it.
Just C & D and associated speed information cleans up the bottom of the chart.
Visual descent point is very important and should be calculated and shown in the lower left area of the chart.
Consider putting runway lengths in this area of the chart.
Generally, too much bolding in all areas of the chart is not good.

Chart Type: **Volpe/ATA Prototype**
Question: 16. Do you need circle-to-land minimums on charts for Part 121 operations?

Comments
It's better to have it consistently appear on the chart, i.e., 1000-3 or higher where needed; put 1000-3 on charts and higher where required.
We need to have effective minimums whether they are 1000-3 or higher.
Not used regularly, but should have minimums shown as 1000-3 or higher.
Only if it's above 1000-3.
These are needed, but they have to be "airline specific"; only if they are higher than company minimums.
Not applicable to the 747, but would be helpful if circle-to-land were authorized.
Circle-to-land is not an instrument approach, when you go visual, you would want to know the minimums.
Saves doing the mental gymnastics.

APPENDIX D - Part 1

Jeppesen Prototype Chart Debriefing Data Summaries

Scaled Response Data Summaries for Each Debriefing Item

Jeppesen Prototype

Question 1: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The information needed to brief the approach or for use in setting up the flight management system has been reformatted in the Heading area of the chart.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		3	14	12	6		35	# Pilots
		8.6%	40.0%	34.3%	17.1%		100.0%	% of Chart
		100.0%	50.0%	40.0%	33.3%		39.3%	% of Column
Jeppesen	2		11	14	9	8	44	# Pilots
	4.5%		25.0%	31.8%	20.5%	18.2%	100.0%	% of Chart
	100.0%		39.3%	46.7%	50.0%	100.0%	49.4%	% of Column
None			3	4	3		10	# Pilots
			30.0%	40.0%	30.0%		100.0%	% of Chart
			10.7%	13.3%	16.7%		11.2%	% of Column
SUM	2	3	28	30	18	8	89	# Pilots
	2.2%	3.4%	31.5%	33.7%	20.2%	9.0%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	3.600	0.881
Z Scores	-0.460	0.809
Range Transformation	0.472	0.227
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.182	1.263
Z Scores	-0.067	0.803
Range Transformation	0.596	0.276
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.000	0.816
Z Scores	-0.074	0.722
Range Transformation	0.560	0.249
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	3.933	1.106
Z Scores	-0.222	0.811
Range Transformation	0.543	0.258

Jeppesen Prototype

Question 2: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The four letter ICAO identifier is included in the Heading of the chart.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM	
Volpe		1	3	12	13	2	4	35	# Pilots
		2.9%	8.6%	34.3%	37.1%	5.7%	11.4%	100.0%	% of Chart
		100.0%	75.0%	38.7%	48.1%	18.2%	28.6%	39.8%	% of Column
Jeppesen			1	16	10	6	10	43	# Pilots
			2.3%	37.2%	23.3%	14.0%	23.3%	100.0%	% of Chart
			25.0%	51.6%	37.0%	54.5%	71.4%	48.9%	% of Column
None				3	4	3		10	# Pilots
				30.0%	40.0%	30.0%		100.0%	% of Chart
				9.7%	14.8%	27.3%		11.4%	% of Column
SUM		1	4	31	27	11	14	88	# Pilots
		1.1%	4.5%	35.2%	30.7%	12.5%	15.9%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	3.686	1.183
Z Scores	-0.456	0.834
Range Transformation	0.482	0.285
Pilots who flew the Jeppesen Chart (N=43)	Mean	Standard Deviation
Raw Scores	4.186	1.239
Z Scores	-0.092	0.831
Range Transformation	0.583	0.306
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.000	0.816
Z Scores	-0.091	0.674
Range Transformation	0.555	0.264
All Pilots (N=88)	Mean	Standard Deviation
Raw Scores	3.966	1.189
Z Scores	-0.237	0.827
Range Transformation	0.540	0.294

Jeppesen Prototype

Question 3: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The frequency and call sign of the primary navaid are presented in large, boldfaced type.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			8	18	7	2	35	# Pilots
			22.9%	51.4%	20.0%	5.7%	100.0%	% of Chart
			53.3%	50.0%	29.2%	16.7%	39.3%	% of Column
Jeppesen		2	6	14	13	9	44	# Pilots
		4.5%	13.6%	31.8%	29.5%	20.5%	100.0%	% of Chart
		100.0%	40.0%	38.9%	54.2%	75.0%	49.4%	% of Column
None			1	4	4	1	10	# Pilots
			10.0%	40.0%	40.0%	10.0%	100.0%	% of Chart
			6.7%	11.1%	16.7%	8.3%	11.2%	% of Column
SUM		2	15	36	24	12	89	# Pilots
		2.2%	16.9%	40.4%	27.0%	13.5%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.086	0.818
Z Scores	-0.122	0.472
Range Transformation	0.573	0.196
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.477	1.110
Z Scores	0.152	0.712
Range Transformation	0.660	0.243
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.500	0.850
Z Scores	0.287	0.731
Range Transformation	0.673	0.240
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.326	0.986
Z Scores	0.059	0.642
Range Transformation	0.628	0.227

Jeppesen Prototype

Question 4: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The chart index number is shown in large, boldfaced type.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots	2	3	17	10	2	1	35
	% of Chart	5.7%	8.6%	48.6%	28.6%	5.7%	2.9%	100.0%
	% of Column	100.0%	60.0%	38.6%	32.3%	40.0%	50.0%	39.3%
Jeppesen	# Pilots		2	19	19	3	1	44
	% of Chart		4.5%	43.2%	43.2%	6.8%	2.3%	100.0%
	% of Column		40.0%	43.2%	61.3%	60.0%	50.0%	49.4%
None	# Pilots			8	2			10
	% of Chart			80.0%	20.0%			100.0%
	% of Column			18.2%	6.5%			11.2%
SUM	# Pilots	2	5	44	31	5	2	89
	% of Chart	2.2%	5.6%	49.4%	34.8%	5.6%	2.2%	100.0%
	% of Column	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	3.286	1.017
Z Scores	-0.723	0.608
Range Transformation	0.401	0.226
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.591	0.787
Z Scores	-0.506	0.478
Range Transformation	0.464	0.191
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	3.200	0.422
Z Scores	-0.667	0.389
Range Transformation	0.385	0.163
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	3.427	0.865
Z Scores	-0.610	0.530
Range Transformation	0.431	0.204

Jeppesen Prototype

Question 5: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

Communications information is arranged vertically and boxed in the order in which the services are used during an approach.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		1	3	10	11	10	35	# Pilots
		2.9%	8.6%	28.6%	31.4%	28.6%	100.0%	% of Chart
		100.0%	50.0%	55.6%	40.7%	27.8%	39.3%	% of Column
Jeppesen	1		3	5	12	23	44	# Pilots
	2.3%		6.8%	11.4%	27.3%	52.3%	100.0%	% of Chart
	100.0%		50.0%	27.8%	44.4%	63.9%	49.4%	% of Column
None				3	4	3	10	# Pilots
				30.0%	40.0%	30.0%	100.0%	% of Chart
				16.7%	14.8%	8.3%	11.2%	% of Column
SUM	1	1	6	18	27	36	89	# Pilots
	1.1%	1.1%	6.7%	20.2%	30.3%	40.4%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.743	1.067
Z Scores	0.417	0.790
Range Transformation	0.728	0.243
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	5.182	1.126
Z Scores	0.701	0.760
Range Transformation	0.834	0.237
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	5.000	0.816
Z Scores	0.674	0.493
Range Transformation	0.778	0.237
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.989	1.082
Z Scores	0.586	0.753
Range Transformation	0.786	0.242

Jeppesen Prototype

Question 6: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

Communications frequencies are shown in boldfaced type.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		2	6	14	8	5	35	# Pilots
		5.7%	17.1%	40.0%	22.9%	14.3%	100.0%	% of Chart
		50.0%	46.2%	51.9%	42.1%	19.2%	39.3%	% of Column
Jeppesen		2	4	10	8	20	44	# Pilots
		4.5%	9.1%	22.7%	18.2%	45.5%	100.0%	% of Chart
		50.0%	30.8%	37.0%	42.1%	76.9%	49.4%	% of Column
None			3	3	3	1	10	# Pilots
			30.0%	30.0%	30.0%	10.0%	100.0%	% of Chart
			23.1%	11.1%	15.8%	3.8%	11.2%	% of Column
SUM		4	13	27	19	26	89	# Pilots
		4.5%	14.6%	30.3%	21.3%	29.2%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.229	1.087
Z Scores	-0.013	0.663
Range Transformation	0.609	0.248
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.909	1.217
Z Scores	0.478	0.733
Range Transformation	0.765	0.254
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.200	1.033
Z Scores	0.079	0.920
Range Transformation	0.600	0.286
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.562	1.187
Z Scores	0.240	0.759
Range Transformation	0.685	0.265

Jeppesen Prototype

Question 7: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

All named approach fixes are shown in bold on one side of the approach course.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots		1	2	11	10	9	33
	% of Chart		3.0%	6.1%	33.3%	30.3%	27.3%	100.0%
	% of Column		100.0%	50.0%	61.1%	45.5%	22.5%	38.8%
Jeppesen	# Pilots			2	3	9	28	42
	% of Chart			4.8%	7.1%	21.4%	66.7%	100.0%
	% of Column			50.0%	16.7%	40.9%	70.0%	49.4%
None	# Pilots				4	3	3	10
	% of Chart				40.0%	30.0%	30.0%	100.0%
	% of Column				22.2%	13.6%	7.5%	11.8%
SUM	# Pilots		1	4	18	22	40	85
	% of Chart		1.2%	4.7%	21.2%	25.9%	47.1%	100.0%
	% of Column		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=33)	Mean	Standard Deviation
Raw Scores	4.727	1.039
Z Scores	0.386	0.645
Range Transformation	0.728	0.229
Pilots who flew the Jeppesen Chart (N=42)	Mean	Standard Deviation
Raw Scores	5.500	0.834
Z Scores	0.892	0.642
Range Transformation	0.883	0.211
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.900	0.876
Z Scores	0.625	0.645
Range Transformation	0.767	0.218
All Pilots (N=85)	Mean	Standard Deviation
Raw Scores	5.129	0.985
Z Scores	0.664	0.679
Range Transformation	0.809	0.229

Jeppesen Prototype

Question 8: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The MSA origin point is shown as a symbol in the MSA circle with the identification shown in bold adjacent to the circle.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe	3	3	4	10	14	1	35	# Pilots
	8.6%	8.6%	11.4%	28.6%	40.0%	2.9%	100.0%	% of Chart
	100.0%	100.0%	36.4%	32.3%	50.0%	7.7%	39.3%	% of Column
Jeppesen			5	16	13	10	44	# Pilots
			11.4%	36.4%	29.5%	22.7%	100.0%	% of Chart
			45.5%	51.6%	46.4%	76.9%	49.4%	% of Column
None			2	5	1	2	10	# Pilots
			20.0%	50.0%	10.0%	20.0%	100.0%	% of Chart
			18.2%	16.1%	3.6%	15.4%	11.2%	% of Column
SUM	3	3	11	31	28	13	89	# Pilots
	3.4%	3.4%	12.4%	34.8%	31.5%	14.6%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Deviations		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	3.914	1.337
Z Scores	-0.205	0.854
Range Transformation	0.550	0.290
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.636	0.967
Z Scores	0.273	0.587
Range Transformation	0.700	0.219
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.300	1.059
Z Scores	0.125	0.871
Range Transformation	0.628	0.282
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.315	1.174
Z Scores	0.068	0.761
Range Transformation	0.633	0.263

Jeppesen Prototype

Question 9: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

MSA sectors are depicted as radial outbound from the origin.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe		2	4	8	11	10	35	# Pilots
		5.7%	11.4%	22.9%	31.4%	28.6%	100.0%	% of Chart
		66.7%	40.0%	50.0%	33.3%	38.5%	39.3%	% of Column
Jeppesen	1	1	4	7	16	15	44	# Pilots
	2.3%	2.3%	9.1%	15.9%	36.4%	34.1%	100.0%	% of Chart
	100.0%	33.3%	40.0%	43.7%	48.5%	57.7%	49.4%	% of Column
None			2	1	6	1	10	# Pilots
			20.0%	10.0%	60.0%	10.0%	100.0%	% of Chart
			20.0%	6.2%	18.2%	3.8%	11.2%	% of Column
SUM	1	3	10	16	33	26	89	# Pilots
	1.1%	3.4%	11.2%	18.0%	37.1%	29.2%	100.0%	% of Chart
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.657	1.187
Z Scores	0.295	0.741
Range Transformation	0.696	0.273
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.841	1.200
Z Scores	0.410	0.725
Range Transformation	0.742	0.270
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.600	0.966
Z Scores	0.368	0.709
Range Transformation	0.685	0.306
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.742	1.163
Z Scores	0.360	0.723
Range Transformation	0.717	0.273

Jeppesen Prototype

Question 10: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

All obstacles outside 1 mile from the approach course have been deleted from the map view.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM	
Volpe		14	7	2	6	5	1	35	# Pilots
		40.0%	20.0%	5.7%	17.1%	14.3%	2.9%	100.0%	% of Chart
		53.8%	38.9%	33.3%	42.9%	33.3%	10.0%	39.3%	% of Column
Jeppesen		7	7	3	8	10	9	44	# Pilots
		15.9%	15.9%	6.8%	18.2%	22.7%	20.5%	100.0%	% of Chart
		26.9%	38.9%	50.0%	57.1%	66.7%	90.0%	49.4%	% of Column
None		5	4	1				10	# Pilots
		50.0%	40.0%	10.0%				100.0%	% of Chart
		19.2%	22.2%	16.7%				11.2%	% of Column
SUM		26	18	6	14	15	10	89	# Pilots
		29.2%	20.2%	6.7%	15.7%	16.9%	11.2%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	2.543	1.633
Z Scores	-1.267	1.209
Range Transformation	0.249	0.325
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	3.773	1.790
Z Scores	-0.329	1.228
Range Transformation	0.523	0.383
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	1.600	0.699
Z Scores	-1.859	0.583
Range Transformation	0.040	0.084
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	3.045	1.802
Z Scores	-0.870	1.287
Range Transformation	0.361	0.378

Jeppesen Prototype

Question 11: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The Final Approach Course is shown in large type.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			6	17	10	2	35	# Pilots
			17.1%	48.6%	28.6%	5.7%	100.0%	% of Chart
			54.5%	51.5%	34.5%	13.3%	39.3%	% of Column
Jeppesen		1	4	11	15	13	44	# Pilots
		2.3%	9.1%	25.0%	34.1%	29.5%	100.0%	% of Chart
		100.0%	36.4%	33.3%	51.7%	86.7%	49.4%	% of Column
None			1	5	4		10	# Pilots
			10.0%	50.0%	40.0%		100.0%	% of Chart
			9.1%	15.2%	13.8%		11.2%	% of Column
SUM		1	11	33	29	15	89	# Pilots
		1.1%	12.4%	37.1%	32.6%	16.9%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.229	0.808
Z Scores	-0.021	0.493
Range Transformation	0.610	0.182
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	4.795	1.047
Z Scores	0.370	0.635
Range Transformation	0.738	0.226
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.300	0.675
Z Scores	0.162	0.541
Range Transformation	0.628	0.230
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	4.517	0.955
Z Scores	0.193	0.596
Range Transformation	0.675	0.217

Jeppesen Prototype

Question 12: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

Procedural and equipment notes are contained in the Notes Box on the map view near the Approach Course Heading.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			2	11	11	11	35	# Pilots
			5.7%	31.4%	31.4%	31.4%	100.0%	% of Chart
			100.0%	61.1%	34.4%	29.7%	39.3%	% of Column
Jeppesen				5	15	24	44	# Pilots
				11.4%	34.1%	54.5%	100.0%	% of Chart
				27.8%	46.9%	64.9%	49.4%	% of Column
None				2	6	2	10	# Pilots
				20.0%	60.0%	20.0%	100.0%	% of Chart
				11.1%	18.7%	5.4%	11.2%	% of Column
SUM			2	18	32	37	89	# Pilots
			2.2%	20.2%	36.0%	41.6%	100.0%	% of Chart
			100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.886	0.932
Z Scores	0.464	0.588
Range Transformation	0.750	0.232
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	5.432	0.695
Z Scores	0.864	0.554
Range Transformation	0.880	0.156
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	5.000	0.667
Z Scores	0.715	0.434
Range Transformation	0.783	0.217
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	5.169	0.829
Z Scores	0.690	0.582
Range Transformation	0.818	0.204

Jeppesen Prototype

Question 13: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The navigation elements of the missed approach procedure have been bolded.

Chart Flown	Much Worse	2	3	4	5	Much Better	SUM	
Volpe			2	9	14	10	35	# Pilots
			5.7%	25.7%	40.0%	28.6%	100.0%	% of Chart
			50.0%	52.9%	41.2%	31.2%	39.3%	% of Column
Jeppesen		2	2	5	16	19	44	# Pilots
		4.5%	4.5%	11.4%	36.4%	43.2%	100.0%	% of Chart
		100.0%	50.0%	29.4%	47.1%	59.4%	49.4%	% of Column
None				3	4	3	10	# Pilots
				30.0%	40.0%	30.0%	100.0%	% of Chart
				17.6%	11.8%	9.4%	11.2%	% of Column
SUM		2	4	17	34	32	89	# Pilots
		2.2%	4.5%	19.1%	38.2%	36.0%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.914	0.887
Z Scores	0.489	0.514
Range Transformation	0.759	0.213
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	5.091	1.074
Z Scores	0.609	0.681
Range Transformation	0.805	0.243
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	5.000	0.816
Z Scores	0.664	0.567
Range Transformation	0.773	0.247
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	5.011	0.971
Z Scores	0.568	0.605
Range Transformation	0.783	0.231

Jeppesen Prototype

Question 14: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The name of the Missed Approach fix is shown in large, boldfaced type on the map.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots		1	4	9	12	9	35
	% of Chart		2.9%	11.4%	25.7%	34.3%	25.7%	100.0%
	% of Column		50.0%	44.4%	34.6%	50.0%	34.6%	40.2%
Jeppesen	# Pilots		1	4	12	10	15	42
	% of Chart		2.4%	9.5%	28.6%	23.8%	35.7%	100.0%
	% of Column		50.0%	44.4%	46.2%	41.7%	57.7%	48.3%
None	# Pilots			1	5	2	2	10
	% of Chart			10.0%	50.0%	20.0%	20.0%	100.0%
	% of Column			11.1%	19.2%	8.3%	7.7%	11.5%
SUM	# Pilots		2	9	26	24	26	87
	% of Chart		2.3%	10.3%	29.9%	27.6%	29.9%	100.0%
	% of Column		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	4.686	1.078
Z Scores	0.293	0.724
Range Transformation	0.705	0.267
Pilots who flew the Jeppesen Chart (N=42)	Mean	Standard Deviation
Raw Scores	4.810	1.110
Z Scores	0.376	0.659
Range Transformation	0.733	0.248
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.500	0.972
Z Scores	0.267	0.731
Range Transformation	0.660	0.310
All Pilots (N=87)	Mean	Standard Deviation
Raw Scores	4.724	1.075
Z Scores	0.330	0.687
Range Transformation	0.713	0.261

Jeppesen Prototype

Question 15: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

Minimum altitudes in the Profile and Minimums Sections are shown in bold type.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM
Volpe	# Pilots			3	4	16	12	35
	% of Chart			8.6%	11.4%	45.7%	34.3%	100.0%
	% of Column			60.0%	30.8%	43.2%	36.4%	39.3%
Jeppesen	# Pilots		1	1	5	16	21	44
	% of Chart		2.3%	2.3%	11.4%	36.4%	47.7%	100.0%
	% of Column		100.0%	20.0%	38.5%	43.2%	63.6%	49.4%
None	# Pilots			1	4	5		10
	% of Chart			10.0%	40.0%	50.0%		100.0%
	% of Column			20.0%	30.8%	13.5%		11.2%
SUM	# Pilots		1	5	13	37	33	89
	% of Chart		1.1%	5.6%	14.6%	41.6%	37.1%	100.0%
	% of Column		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=35)	Mean	Standard Deviation
Raw Scores	5.057	0.906
Z Scores	0.589	0.582
Range Transformation	0.783	0.214
Pilots who flew the Jeppesen Chart (N=44)	Mean	Standard Deviation
Raw Scores	5.250	0.918
Z Scores	0.724	0.538
Range Transformation	0.843	0.202
Pilots who did not fly (N=10)	Mean	Standard Deviation
Raw Scores	4.400	0.699
Z Scores	0.255	0.511
Range Transformation	0.653	0.217
All Pilots (N=89)	Mean	Standard Deviation
Raw Scores	5.079	0.920
Z Scores	0.618	0.566
Range Transformation	0.798	0.214

Jeppesen Prototype

Question 16: *Compared to the Standard Chart, how much better or worse does the following feature make the prototype?*

The airport is highlighted with a shaded circle.

Chart Flown		Much Worse	2	3	4	5	Much Better	SUM	
Volpe		3	6	10	4	2		25	# Pilots
		12.0%	24.0%	40.0%	16.0%	8.0%		100.0%	% of Chart
		33.3%	46.2%	38.5%	57.1%	40.0%		41.0%	% of Column
Jeppesen		6	6	11	3	2	1	29	# Pilots
		20.7%	20.7%	37.9%	10.3%	6.9%	3.4%	100.0%	% of Chart
		66.7%	46.2%	42.3%	42.9%	40.0%	100.0%	47.5%	% of Column
None			1	5		1		7	# Pilots
			14.3%	71.4%		14.3%		100.0%	% of Chart
			7.7%	19.2%		20.0%		11.5%	% of Column
SUM		9	13	26	7	5	1	61	# Pilots
		14.8%	21.3%	42.6%	11.5%	8.2%	1.6%	100.0%	% of Chart
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	% of Column

Mean and Standard Deviation of Scaled Estimates		
Pilots who flew the Volpe Chart (N=25)	Mean	Standard Deviation
Raw Scores	2.840	1.106
Z Scores	-1.052	0.723
Range Transformation	0.318	0.238
Pilots who flew the Jeppesen Chart (N=29)	Mean	Standard Deviation
Raw Scores	2.724	1.306
Z Scores	-1.061	0.791
Range Transformation	0.283	0.265
Pilots who did not fly (N=7)	Mean	Standard Deviation
Raw Scores	3.143	0.900
Z Scores	-0.809	0.703
Range Transformation	0.343	0.232
All Pilots (N=61)	Mean	Standard Deviation
Raw Scores	2.820	1.176
Z Scores	-1.028	0.746
Range Transformation	0.304	0.247

APPENDIX D - Part 2

Jeppesen Prototype Chart Debriefing Data Summaries

Part 2 - Crew Comments Regarding Each Chart Design Feature

Chart Type: **Jeppesen Prototype** **Question:** 1. The information needed to brief the approach or for use in setting up the flight management system has been reformatted in the Heading area of the chart.	
Comments	

Comments Related to Briefing the Approach/Setting Up the FMS

Not all of the information needed for briefing is in the heading; there isn't any FMS information in the heading.
The only briefing information in the heading is frequency and MSA circle information, however, prefer the new format.
Don't see a whole lot of change; looks the same with a few cosmetic changes.
This heading is not complete, much prefer the Briefing Strip in the other (V/ATA) prototype.
Neutral, not significantly different than the standard chart.
The heading area seems better organized for briefing.

Comments Related to Format and Heading Features

The format, highlighting of frequencies and bolding is better.
It's formatted better and easier to see; the format is a little bit better than the standard chart.
Communication information is so much clearer; the frequencies are easier to find and read; frequency arrangement is better.
Emphasis on bolding is good, it helps older pilots.
The layout of the MSA and the communication areas is better.
Prefer MSA altitudes shown as 2600, 3400 rather than 2_6, 3_4 altitude sectional chart notation, but could get used to it.
Like the bold of the primary navaid and runway.
Except for the format of the frequencies, the rest of the information is not significantly different than the current chart.
Don't need the details of the primary navaid (frequency and call sign) in the header.
Recommend putting the ICAO identifier closer to the name of the airport.

Chart Type: **Question:** 2.	**Jeppesen Prototype** The four letter ICAO identifier is included in the Heading of the chart.

Comments
It's a little bit better, you don't have to turn the page; better than looking for it on other pages.
For international operations it's important, however, for domestic operations couldn't care less; for international purposes, good. Significantly better for international operations. Need the identifier for the FMS.
Useful in an FMC type aircraft.
It's not needed. It's already on the airport page and flight plan.
Wouldn't look for it. That's set up before you depart. Doesn't think it belongs on the chart, but it doesn't hurt.
It's not evident. Would like to see it with the name of the area and quite large. It assures one has the correct approach plate. Especially important when flying across several countries; relocate the ICAO identifier closer to the name of the airport.
Neutral, doesn't matter; don't use it, it's alright where it is.
Redundant information, because the plate and the airport have the same name.
Consider deleting "Apt." in, for example, "KDFW Apt. Elev".

Chart Type: **Question:** 3.	**Jeppesen Prototype** The frequency and call sign of the primary navaid are presented in large, boldfaced type.

Comments
It's easier to read; makes it easy to get the essential information for the approach; everything in bold is better.
Mistakes in (reading) any of the information is critical for the whole approach; most important thing on the chart.
Don't ever look for this information up in the heading area, get it from the "shadow box" in the plan view; always look for this information in the map (plan view) area.
Neutral about it. Depends where you look for it; not that much different than standard chart.
Have the overall impression that too many things are bolded.
Can't tell the difference whether these features are bolded or not bolded.
Don't really care for the bold type anywhere, especially the number "8" in bold.

Chart Type:	**Jeppesen Prototype**
Question: 4.	The chart index number is shown in large, boldfaced type.

Comments
It's a real important item, easier to locate the correct chart and read the chart index number; can see the chart index better.
Easier to index when looking for the chart, or when revising the chart.
Neutral, it's in the same location, only look at that information once; not really a significant change.
Didn't really notice any difference from the standard chart; looks the same, not much difference.
Clip tends to cover that information, move the chart index number to the top right side, over the airport location or move to the left side in place of the JEPPESEN name; in it's location on the chart the clip will cover it up.
Date more important than the chart index number, therefore, the date should be bolded.
More important to read the name of the chart location, therefore, it should be in boldfaced type.

Chart Type:	**Jeppesen Prototype**
Question: 5.	Communications information is arranged vertically and boxed in the order in which the services are used during an approach.

Comments
It's an improvement; big improvement; much better.
New format makes it easier to read and locate the desired facility; the format and bolding is good in low light.
It's amazing how much clearer and easier it is to pick up required frequencies because they're all lined up; familiar with the vertical alignment, columns and bolding of information makes it better.
It's a lot better, the information is arranged so it is easy to locate; don't have to search for required information.
LA chart has too many frequencies. Too much bolding. Tower frequencies are more important, prefer to have more significant frequencies first on top and less significant ones below. ATIS doesn't need to be in the position it is. It could be lower.
In the vertical format an improvement would be to add vertical lines to separate frequencies to improve the alignment and readability of this information.
It's the only significant improvement in this prototype.
Compared to the standard chart, this change is not a big deal.

Chart Type: Jeppesen Prototype Question: 5. Communications information is arranged vertically and boxed in the order in which the services are used during an approach. (Continued)
Comments
The frequency numbers, as shown on the examples, look alike. This arrangement does not help to find needed information quickly.
An improvement might be a graphic depiction of the division of the communication facilities, e.g., East and West, possibly on the map (plan) view.
Primarily need the ATIS and the ground frequencies, but not necessarily from the chart. Gets ATIS from ATC and ground from ATIS.
Don't need ATIS on the chart, get it from ATC.

Chart Type: Jeppesen Prototype Question: 6. Communications frequencies are shown in boldfaced type.
Comments
Displaying communication frequencies in boldfaced type is better than on the standard chart.
Good for visual acuity, but not needed for emphasis; great for the night environment.
Concerned about too much bolding leading to loss of emphasis; although would like the facility names in bold, feel that too much bolding is not good. Defeats the intended purpose.
It's better, East and West are depicted correctly, whereas, in the other concept (V/ATA) East and West are reversed.
Put the runway these frequencies are good for, not which part of the compass.
Primary frequencies should stand out more.
Don't look in this area of the chart for the information, it's already in the right corner of the chart.
121 operations don't need helicopter frequencies on these charts.
Consider deleting the word "Regional" in the Tower title.
This information doesn't need to be in bold, put the information that is going to kill you in bold.

Chart Type: **Jeppesen Prototype** **Question:** 7. All named approach fixes are shown in bold on one side of the approach course.
Comments
That's a definite improvement; it's easy to pick out; it's easier to read.
Helps in finding the information; avoid looking all over for the names; having them all on one side is significantly better.
The standard chart arrangement of fixes is hard to use compared to this prototype chart.
Would like to have DME and crossing altitudes for each fix to include bolding; both the fix and the DME should be bolded; the altitudes should be bolded.
Too much boldface tends to make reading too bunched up; too much getting bolded, it no longer stands out.
All the fixes on one side is better, but they don't need to be bolded.
The fix names don't have to be bolded, it's the DME distance that is most important to see.
Reduce the amount of bolding. Use outline or shadow techniques.
It's consistent with the "glass cockpit" navigation display.
On an approach that has a lot of step-downs this arrangement may become confusing.
Consider adding Lat/Long of approach fixes to the charts.

Chart Type: **Jeppesen Prototype** Question: 8. The MSA origin point is shown as a symbol in the MSA circle with the identification shown in bold adjacent to the circle.
Comments
Showing the reference is better; it's a lot better; it's handy to have it there; this is better than the standard chart.
Where possible, a graphic representation is better than words alone.
Provided that it includes any type of navaid, e.g., an NDB, the concept is good.
Good to have the information shown, without all of the information you don't know where it is centered.
It's redundant information, don't need the symbol plus the description of what the symbol is, just put the minimal information.
Prefer the MSA presentation on the other (V/ATA) prototype.
Neutral, a non-event.

Chart Type:	**Jeppesen Prototype**
Question: 9.	MSA sectors are depicted as radial outbound from the origin.

Comments
Big improvement; better concept.
It makes sense, it's easier to understand; better, don't have to interpolate anything.
Always think in radials.
Just use the geographic orientation, radials are of no help.
Use the circle only as a graphic depiction with a north-up orientation, but better to have the sectors depicted as radial outbound from the origin.
The more dangerous or safest sector should be shaded in some way.
Show the full altitude, for example, use 2600, not $\mathbf{2}_6$, it's not consistent.

Chart Type:	**Jeppesen Prototype**
Question: 10.	All obstacles outside 1 mile from the approach course have been deleted from the map view.

Comments
Need to know where the "tallest" obstacles are on the plate, i.e., the ones with the big arrows; want to see the obstacles with the big arrows remain on the chart; don't need them all, but really need highest obstacles; the highest obstacles on the prototype chart don't really jump out, have to make a real conscious effort to find them.
Although very helpful not to have all that clutter, would like significant obstacles within 5 miles of the approach course on the chart; obstacle information is not needed unless you are 5 miles off course and 1000 feet below altitude.
Want to have airports remain on the chart even if no obstacles are shown; if an airport has a paved runway want to see them on the chart; knowing where other airports are aids in finding ours more easily.
For ILS in 121 operations don't need to identify obstacles outside 1 mile either side of the approach course; cleans up the chart, therefore, anything that eliminates clutter is better.
It cleans up the chart, but like to see where the obstacles are, especially in a missed approach situation.
Can't generalize. Decision has to be made, approach plate by approach plate. Depends on how close in altitude obstacles are from you; a pilot review board should decide, approach by approach rather than an engineer.
Wants all obstacles above some defined level to appear on the chart; retain all obstacles; don't delete obstacle information.

Chart Type:	**Jeppesen Prototype**
Question: 10.	All obstacles outside 1 mile from the approach course have been deleted from the map view. (Continued)

Comments
Obstacles and highest obstacle information should be retained. The chart is the only place where obstacles are shown. Makes you aware of the obstacles and the kind of area that you are flying into; both obstacle and airport data should remain as on the standard chart. Airports give you traffic awareness information; pilot studies the charts before flying to become aware of such things as obstacles and nearby airports. Good information to have.
Likes the inclusion of geographic features in the plan view, especially if you're flying a "round dial" with an FMS that's not up to snuff. It reinforces where you are when you break out; contour lines on some charts would be helpful.
In foreign operations, e.g., South America, you can "do what you want to", therefore, need all obstacle and airport information; when flying into uncontrolled or unfamliar airports, need obstacle information.
Need all obstacle and airport information at some U.S. airports, e.g., Miami area, tall hotel and office buildings.
Obstacle information is especially important in an engine out, go-around situation.
Consider deleting lat-long information, never used lat-long in 15 years. Internationally you might.

Chart Type:	**Jeppesen Prototype**
Question: 11.	The Final Approach Course and related information is shown in large type.

Comments
It's better. Easier to read. Any of the major elements on the chart should be bold.
Anything that makes it easier to read inside an airplane is better, especially in low light conditions.
It's a little better in large type; like the bolding and larger type; eyes went right to it.
Pulls the information right up out of the clutter; nice to see it quickly, good for manual airplanes.
Neutral, the large type doesn't make any difference; not a big deal; doesn't do anything.
For an ILS approach bolding is not important, but for a non-precision approach the course should be bolded on both sides of the beacon.
This information is shown better on the other prototype (V/ATA) chart; in a box would even be better.

Chart Type:	**Jeppesen Prototype**
Question: 11.	The Final Approach Course and related information is shown in large type.
	(Continued)

Comments
The approach course is shown too many times--needed only once at the top of the chart.
For an ILS approach, don't read this information on the map, get it from the primary navaid box.
Doesn't need to be larger, big enough to see on the standard chart.
For an ILS approach, delete the feathers. Considers it clutter and not needed.
When there is a DME associated with a final approach fix, would like it in bold.
Consider a horizontal presentation of the approach heading, the vertical presentation on the Dallas chart is difficult to read.

Chart Type:	**Jeppesen Prototype**
Question: 12.	Procedural and equipment notes are contained in the Notes Box on the map view near the Approach Course Heading.

Comments
Compared to the standard chart, this is better; the box and bolding is much better; significantly better, picked up information not seen before.
Looks so logical to put it there; positive, like the warning on a pack of cigarettes.
All notes including the altitude notes in the profile view should be in the notes box in one location; all the equipment and procedural notes should be pulled together and put into a box.
Like the box. Items should be bulleted to make it more clear and separated; hard to tell how many notes in the box. Maybe each should be bulleted as an aid to pick them out.
Notes in the profile view should also be boxed to be consistent.
Procedural and equipment notes are presented better in the other (V/ATA) prototype chart, however, it's an improvement over the standard chart; prefer all notes in the heading for briefing.
The box is enough to get your attention. There's enough bolding already. Don't need bolding in the box; elements don't need to be bolded.
It would be good if the notes box appeared in the same location on every chart, otherwise the box needs to be emphasized so it stands out more; the box needs to be more visible; since the box could not always be in the same location in the map view, it would be better to define a fixed location outside the map view.

Chart Type: **Jeppesen Prototype** **Question:** 12. Procedural and equipment notes are contained in the Notes Box on the map view near the Approach Course Heading. (Continued)
Comments
It would be good if the notes box appeared in the same location on every chart, otherwise the box needs to be emphasized so it stands out more; the box needs to be more visible; since the box could not always be in the same location in the map view, it would be better to define a fixed location outside the map view.
A notes box or other distinctive coding to visually help in locating (find) the notes is more important than where on the chart the box is placed.
Notes that appear in the profile view shouldn't be bolded since it is not primary information there.
Each note should be displayed close to the segment of the approach to which it applies.
ATC related notes are not needed and should be removed; simultaneous approach notes are not needed.
Notes should be moved to the white space below the minimums area on the chart.

Chart Type: **Jeppesen Prototype** **Question:** 13. The navigation elements of the missed approach procedure have been bolded.
Comments
That's excellent. Much easier to read that way; for a quick reference, boom, it's right there.
On a lengthy procedure, normally highlight these elements; bolding is good; it is good to have those elements emphasized.
The missed approach text should be near the heading with the key elements bolded for emphasis.
The missed approach fix, (e.g., "Blitz", Dallas-Ft Worth chart) should be part of the profile view, shouldn't have to go back to plan view; all missed approach information should be in one place.
The chart is read from the top down, why do you have to go back up to find information. All the missed approach information should be together; missed approach fix information is presented better on NOS charts, the airport is centered and the missed information is shown aligned with the approach.
Consider putting in the altitude for the missed approach fix for a standard missed approach procedure.
In terms of bolding, it's important that the glide slope be bolded so it's easy to see.

Chart Type: **Jeppesen Prototype** **Question:** 13. The navigation elements of the missed approach procedure have been bolded. (Continued)
Comments
The bolding is good, but the fixes should be presented in a stepped down manner relative to the glide slope.
Prefer the missed approach procedure icons in the profile view as shown on the other (V/ATA) prototype chart.
Even though bolding helps visual acuity, there is too much bolding for it to be considered a means of emphasis.

Chart Type: **Jeppesen Prototype** **Question:** 14. The name of the Missed Approach fix is shown in large, boldfaced type on the map.
Comments
It is more readable; much better.
Consistent with the bold in the script; highlighted information is good.
The missed approach fix name can be used better on an FMS equipped aircraft because the fix name alone will get you there; the name is more useful to FMS aircraft, manual aircraft need to be able to tune in the VOR.
Not important in a glass cockpit since the missed approach fix is already in the waypoint list.
The missed approach fix depiction should be in correct orientation with the approach course.
The altitude for the missed approach fix should also be specified.
The DME for the fix should be included.
Neutral, the standard chart and the prototype look OK; insignificant; only a little bit better.
Procedure turn information should also be included.
Prefer this information not be highlighted.

Chart Type: **Jeppesen Prototype** **Question:** 15. Minimum altitudes in the Profile and Minimums Sections are shown in bold type.
Comments
It's an improvement; easier to see; stands out better.
Too much bold in name of fixes, but like the altitudes in bold.
Had trouble picking up the DME under the fixes in the profile view but it really stands out on the prototype near the MAP. Consider bolding all the DME's in the profile view but less bold then MAP DME.
Ground speed section of the chart should only show information for category C&D aircraft. Category A&B information should be removed; times in the ground speed section should be to the nearest 5 seconds, eg., Dallas chart for Runway l8L, HASTY to MAP at 140 knts, is 2:11, feels that 2:10 is close enough.
The VDP information should be included in the minimums section on all charts.
The TCH should be bolded. Use this information in setting the radar altimeter.
Minimums and ground speed information should be at the top of the chart, since it is the first information used to determine if the approach is allowable.
There may be too much bolding in these sections.
Right empty box (bottom) appears to be wasted space, it could be used for such purposes as change notes.

Chart Type: **Jeppesen Prototype** **Question:** 16. The airport is highlighted with a shaded circle.
Comments
Don't care for it. It's absolutely no value whatsoever; don't like or need it.
Don't like or need it; don't know the significance of the shaded circle.
Don't know what it means; the circle doesn't cover the whole airport, don't know what the circle is supposed to cover.
Neutral, doesn't matter; prefer the standard chart way.
It may be useful information if there were similar airports on the same plate.
The feathers on an ILS chart accomplish the same thing, they end at the runway.
The shaded circle makes the runways stand out more.

APPENDIX E

Crew/Pilot Observer Comments Made During Simulator Sessions

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - CHICAGO, ILL - ILS 14R	
Chart Type	Comment
S	Crew commented on amount of "clutter" with obstructions shown on this standard chart.
S	Crew stated the plan view missed approach graphic on this chart can be easily misinterpreted since the missed approach course points directly at the DPA VOR radial of 085. Recommended that in addition to showing the DPA VOR radial of 085 the inbound course of 265 should be displayed to avoid setting in the wrong course.
S	Having completed a simulator run using a prototype chart and then initiating an approach with this standard chart, crew commented about the lack of MAP icons for executing a go around using the standard chart.
J	Missed approach briefed by PF inbound to DPA course 085, rather than radial (inbound course 265). Suggested inbound course to VOR be listed.
J	Discussion of the need for bolding the DME rather than appropriate fix name.
J	PF briefed Runway width and length which is not on the chart. Recommends runway length and width be included.
J	Commented on need for more top plate margin in order to get plate under clip without blocking vital information.
J	Crew commented that on executing an early missed approach (before breakout) need some indication of MAP on plan view/profile view.
V	Crew stated missed approach procedure should show course 265 to DPA to avoid mistake of setting in 085.
V	PNF - MSA distance difficult to determine when center located at NDB such as ROAMY. PF - Liked the MSA circle out of the top of the chart and on the plan view.
V	PNF gave MAP instructions using the icons. Commented on the ease of use of the pictographs (icons).

S = Standard Chart J = Jeppesen Prototype Chart V = Volpe/ATA Prototype Chart

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - CHICAGO, ILL - VOR 22R	
Chart Type	Comment
S	VDP depiction could be shown along with DME MAP.
S	Discussion of lack of lighting information on standard chart. Prototype (V/ATA) chart much better.
S	Missed approach information should be in bold.
S	PNF noted difficulty of seeing important information on bottom of chart due to poor lighting and placement on chart. Suggested fix - put profile and MAP procedure up above plan view.
V	Stepdown fixes should be in bold print, plan view should include Morse Code with primary navaid and bolding of DME fixes.
V	PF preferred box around inbound course. He could cross check plan view inbound course against that listed in the briefing strip.
V	Some searching for flow of information during briefing (1st time use of prototype chart).
V	PNF - "It would be nice to have runway length included in the briefing strip".

S = Standard Chart   J = Jeppesen Prototype Chart   V = Volpe/ATA Prototype Chart

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - LOS ANGELES, CALIF - VOR RWY 25L/R	
Chart Type	Comment
S	PF - "After you've used the other prototype (V/ATA) you sure don't want to go back".
S	Lined up on wrong runway, caught error due to approach lights on 10-9 chart. Landed on correct runway.
S	Comment - Take out airport depictions, leave only highest obstructions. "Looks like a bowl of Cheerios".
S	Crew never briefed notes.
S	PF briefed on approach lights from 10-9 chart.
J	On approach PF liked "clean profile" on plate
J	PNF found Tower Frequencies easier to locate.
J	PF would like DME in bold.
J	PNF recommends that Departure frequencies should be on chart.
J	Crew noted DME indications in prototype charts need to be bolder.
J	PNF likes bolding of missed approach text.
J	Marked chart with calculation to VDP.
J	PNF commented lack of clutter on this plate.
V	Crew felt DH and MDA could be "rounded off" to nearest 10 feet.
V	Crew commented favorably on the missed approach procedure icons in the profile view.
V	Approach lighting shows "ALS" for which runway 25L or 25R?
V	Communication - Approach section of briefing strip has too many choices depending on Quadrant.
V	PNF misread the DME FREBY.
V	Stated having all notes in a box really helps.
V	Used lighting icon to determine correct runway.

S = Standard Chart J = Jeppesen Prototype Chart V = Volpe/ATA Prototype Chart

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - LOS ANGELES, CALIF - ILS RWY 24R	
Chart Type	Comment
S	Crew commented on the amount of clutter on this standard plate versus the prototype (V/ATA).
S	Crew commented about the difficulty of finding information on standard chart.
V	PF stated that he used icons as visual reference to picture the missed approach.
V	Both PF and PNF stated they felt more comfortable with prototype.
V	PF briefed using icons for missed approach.
V	Broke out and saw two runways, used lighting icon to verify correct runway.

S = Standard Chart J = Jeppesen Prototype Chart V = Volpe/ATA Prototype Chart

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - DENVER, COLO - NDB RWY 26L	
Chart Type	Comment
S	Read approach bearing as 268, published on chart is 258.
S	Negative comment regarding placement of notes.
S	Crew never briefed notes.
J	PF called DME to ALTUR and noted lack of VASI lights (this information is not on plate).
J	Comment - Figuring VDPs is always a cumbersome problem.
J	PNF noted prototype plan view "nice and clean" and "bolding really stands out".
J	Crew calculating VDP.
J	Stated notes up in box was a big help.
J	Crew commented that minimum altitudes for descent to 7500' are given as distance yet no real definite way of determining distance for being within 10 miles or crosschecking ALTUR via DEN VOR. Suggested give DME off DEN VOR for "let down" and as crosschecks for distance from ALTUR.
V	PNF recommends bolding of missed approach fix in plan view.
V	PF briefed using the briefing strip. Felt comfortable with the concept.
V	Liked the inclusion of approach lights on plate.
V	Used ALS identification on briefing strip for crosscheck on final.

S = Standard Chart J = Jeppesen Prototype Chart V = Volpe/ATA Prototype Chart

PILOT-OBSERVER COMMENTS REGARDING APPROACH PLATE USAGE AND CREW COMMENTS DURING SIMULATOR SESSIONS

INSTRUMENT APPROACH PLATE FOR - DENVER, COLO - ILS DME -1 RWY 8R	
Chart Type	Comment
S	PNF commented, "we have no idea of the approach light configuration with this plate".
S	Primary NAV frequency does not show DME.
J	Primary NAV frequency does not show DME.
J	PF indicated approach direction toward MSA be shown in the MSA circle (should show an arrow pointing from West to East in circle).
J	During initial approach, PF noted "cleaner plate".
J	PNF liked bolding of fixes and displayed on one side of the plan view.
J	ILS designator doesn't show DME designation.
V	Briefed using icons and PNF expressed he was in support of the picture representation of the missed approach.
V	Recommended the briefing strip concept and missed approach text near the top of the plate.
V	Crew recommended profile view and "up and out" icons moved near top of plate to allow for quick reference where light is best. Would allow them to keep track of the missed approach and fly the aircraft.
V	Crew liked the concept of being able to quickly see outer marker altitude in the briefing strip.
V	On "breakout" aircraft aligned left of runway, PF used approach lighting icon to determine correct runway.

S = Standard Chart   J = Jeppesen Prototype Chart   V = Volpe/ATA Prototype Chart